IDC Performance Report
December 15, 1996 - January 11, 1997

IDC Staff - January 28, 1997

INTRODUCTION AND SUMMARY

This report summarizes the operational and scientific performance of the International Data Center (IDC) for the period December 15, 1996 through January 11, 1997. The IDC is not an operational system; rather, it is a prototype system that continues to change. This report is an internal document for monitoring the IDC in order to identify and fix problems in a timely fashion. Text with new information content since the last report is shown in *italics*.

The primary and auxiliary seismic networks now consist of 35 and 36 stations, respectively, and the acoustic network consists of 8 hydroacoustic stations. In addition, data are continuously received from 4 infrasound stations. Particulate and gas samples are collected and reviewed regularly from 17 radionuclide stations. *One of these, AR001 in Argentina, was added to the network at the end of December. However, the total number of radionuclide stations has not changed since the last report, because it was decided to change the name of SE002 to SE001 and regard it as part of that station.*

A total of 1556 events (56 per day) were reported in the Reviewed Event Bulletin (REB) for this period. Of these, 2% were added by analysts, 58% included auxiliary arrivals, and 19% included hydroacoustic data. Significant delays in automatic processing occurred on a few days due to hardware failures and a DNS problem that prevented restarting of data diskloops. Difficulties with new subscription software were responsible for REB distribution delays on a few days this period.

System improvements included a completely new subscription system, several upgrades to the continuous data forwarding software, DFX recall processing, improved problem logging in the data parsing program, online time block allocation for analysis, and patches to DFX and ARS.

New measurements now presented in this report include statistics on both data timeliness for infrasound stations (Figure 9) and on the usage of associated but non-defining phases for primary and hydroacoustic stations (Figures 29 and 30).

OPERATIONAL SUMMARY

A. Stations and Communications

The 14 arrays and 21 3-component (3C) stations of the primary network are shown in Figure 1 and listed in Table 1. The numbers of elements for arrays in Table 1 refer to distinct sites. At some arrays, data from more than one channel are available from a given site (e.g., horizontal components or channels with a different pass band). New stations added to a network during the period of a report are flagged and do not appear in analysis until the next report, so that they may be compared on an equal time basis with other stations. BJT will remain in primary status until replaced by LHZ, and LOR will continue to serve in primary capacity, until it becomes available via AutoDRM. NOA will replace NORES as a primary array, when testing of processing software modifications to handle data from large-aperture arrays has been completed and installation approved. *The IDC resumed accepting MNV data, beginning December 16, after faulty instrumentation was replaced at the site.*

The auxiliary network currently consists of 4 arrays and 32 3-component stations (Table 2 and Figure 2). These numbers exclude 15 stations accessed by telephone modem, which are not presently used by the IDC, except under special circumstances (flagged in Table 2). New auxiliary stations added to the network during the period of a report are flagged and excluded from analysis until the next report. Stations shown as temporary substitutes will eventually be replaced by nearby IMS stations.

Table 1: Primary seismic stations

Code	Lat.	Lon.	Name	Country	Type	# of elements
ABKT	**37.93**	**58.12**	**Alibek**	**Turkmenistan**	**3C**	
ARCES	**69.53**	**25.51**	**ARCESS Array**	**Norway**	**Array**	**25**
ASAR	**-23.67**	**133.90**	**Alice Springs Array**	**Australia**	**Array**	**19**
BDFB	**-15.64**	**-48.01**	**Brasilia**	**Brazil**	**3C**	
BGCA	**5.18**	**18.42**	**Bogoin**	**Central African R**	**3C**	
BJT	40.02	116.17	Baijiatuan	China	3C	
BOSA	**-28.61**	**25.26**	**Boshof**	**South Africa**	**3C**	
CMAR	**18.46**	**98.94**	**Chiang Mai Array**	**Thailand**	**Array**	**18**
CPUP	**-26.33**	**-57.33**	**Villa Florida**	**Paraguay**	**3C**	
DBIC	**6.67**	**-4.86**	**Dimbroko**	**Ivory Coast**	**3C**	
ESDC	**39.68**	**-3.96**	**Sonseca Array**	**Spain**	**Array**	**19**
FINES	**61.44**	**26.08**	**FINESS Array**	**Finland**	**Array**	**16**
GERES	**48.85**	**13.70**	**GERESS Array**	**Germany**	**Array**	**25**
HIA	**49.27**	**119.74**	**Hailar**	**China**	**3C**	
ILAR	**64.77**	**-146.89**	**Eielson Array**	**U.S.A.**	**Array**	**21**
KBZ	**43.73**	**42.90**	**Khabaz**	**Russia**	**3C**	
KSAR	**37.44**	**127.88**	**Wonju Array**	**South Korea**	**Array**	**25**
LOR	47.27	3.86	Lormes	France	3C	
LPAZ	**-16.29**	**-68.13**	**La Paz**	**Bolivia**	**3C**	
MAW	**-67.60**	**62.87**	**Mawson**	**Antarctica**	**3C**	
MJAR	**36.54**	**138.21**	**Matsushiro Array**	**Japan**	**Array**	**7**
MNV	**38.43**	**-118.15**	**Mina**	**U.S.A.**	**3C**	
NORES	60.74	11.54	NORESS Array	Norway	Array	25
NRI	**69.01**	**88.00**	**Norilsk**	**Russia**	**3C**	
PDAR	**42.77**	**-109.56**	**Pinedale Array**	**U.S.A.**	**Array**	**13**
PDY	**59.63**	**112.70**	**Peleduy**	**Russia**	**3C**	
PLCA	**-40.73**	**-70.55**	**Paso Flores**	**Argentina**	**3C**	
SCHQ	**54.83**	**-66.83**	**Schefferville**	**Canada**	**3C**	
STKA	**-31.88**	**141.60**	**Stephens Creek**	**Australia**	**3C**	
TXAR	**29.33**	**-103.67**	**TXAR Array**	**U.S.A.**	**Array**	**9**
ULM	**50.25**	**-95.88**	**Lac du Bonnet**	**Canada**	**3C**	
VNDA	**-77.51**	**161.85**	**Vanda**	**Antarctica**	**3C**	
WRA	**-19.94**	**134.34**	**Warramunga Array**	**Australia**	**Array**	**20**
YKA	**62.49**	**-114.61**	**Yellowknife Array**	**Canada**	**Array**	**22**
ZAL	**53.62**	**84.79**	**Zalesovo**	**Russia**	**3C**	

Bold type = IMS station; normal type = temporary substitute for IMS station (except LOR, which will be discontinued when available via AutoDRM).
* If present, indicates new station added during the period of this report. New stations are excluded from analysis.

The acoustic network now consists of 8 hydroacoustic stations, one of which (VIB) records seismic T phases. Stations of the hydroacoustic network are shown in Table 3 and Figure 3, along with the four infrasound stations from which the IDC is currently receiving continuous data. The IDC has been receiving continuous data from the hydroacoustic stations, NZL01 and NZL06 in New Zealand, since December 12 (Figure 3). *However, their first-in/first-out protocol and problems with communications near the station ends of the links cause the data to lag several days behind real time. The stations will be incorporated into the network, when such problems have been satisfactorily resolved.* The infrasound stations are analyzed later in this report only with respect to data availability and timeliness. *and timeliness,* because the IDC processing software is not yet capable of handling these kinds of data.

The 17 stations of the radionuclide network from which the IDC currently receives data are shown in Table 4 and Figure 4. *A new particulate station, AR001 in Argentina, was added to the network this period (first stop date: December 31) and began sending data to the IDC on January 6. After SE002 was first used to designate the particulate sampling site in Sweden (See the October 20 - November 16, 1996 performance report), it was decided not to distinguish this site from the co-located site for gas measurements, SE001. Both sites are now referred to as SE001.*

Table 2: Auxiliary seismic stations

Code	Lat.	Lon.	Name	Country	Type	# of elements
AAE #	9.03	38.77	Addis Ababa	Ethiopia	3C	
AFI #	**-13.91**	**-171.78**	**Afiamalu**	**Western Samoa**	**3C**	
ALQ	**34.94**	**-106.46**	**Albuquerque**	**U.S.A.**	**3C**	
AQU #	42.35	13.41	L'Aquila	Italy	3C	
ARU	**56.43**	**58.56**	**Arti**	**Russia**	**3C**	
BBB	**52.18**	**-128.11**	**Bella Bella**	**Canada**	**3C**	
BORG	**64.75**	**-21.33**	**Borgarfjordur**	**Iceland**	**3C**	
CTA	**-20.09**	**146.25**	**Charters Towers**	**Australia**	**3C**	
DAV #	**7.09**	**125.57**	**Davao**	**Philippines**	**3C**	
DAVOS	**46.84**	**9.79**	**Davos**	**Switzerland**	**3C**	
DLBC	**58.44**	**-130.03**	**Dease Lake**	**Canada**	**3C**	
EKA	**55.33**	**-3.16**	**Eskdalemuir Array**	**U.K.**	**Array**	**20**
ELK	**40.74**	**-115.24**	**Elko**	**U.S.A.**	**3C**	
FITZ	**-18.10**	**125.64**	**Fitzroy Crossing**	**Australia**	**3C**	
FRB	**63.75**	**-68.55**	**Iqaluit**	**Canada**	**3C**	
HFS	**60.13**	**13.70**	**Hagfors Array**	**Sweden**	**Array**	**8**
HNR #	**-9.43**	**159.95**	**Honiara**	**Solomon Islands**	**3C**	
INK	**68.31**	**-133.52**	**Inuvik**	**Canada**	**3C**	
ISG	24.38	124.23	Ishigaki-jima	Japan	3C	
JER	31.77	35.20	Jerusalem	Israel	3C	
JTS	**10.29**	**-84.95**	**Las Juntas de Abanga**	**Costa Rica**	**3C**	
KIEV #	50.69	29.21	Kiev	Ukraine	3C	
KKJ	41.78	140.18	Kaminokuni	Japan	3C	
KVAR	**43.96**	**42.70**	**Kislovodsk Array**	**Russia**	**Array**	**4**
LSZ #	**-15.28**	**28.19**	**Lusaka**	**Zambia**	**3C**	
MBC	**76.24**	**-119.36**	**Mould Bay**	**Canada**	**3C**	
MLR	**45.49**	**25.94**	**Muntele Rosu**	**Romania**	**3C**	
MSEY	-4.67	55.48	Mahe	Seychelles	3C	
NEW	**48.26**	**-117.12**	**Newport**	**U.S.A.**	**3C**	
NIL	33.65	73.25	Nilore	Pakistan	3C	
NNA	**-11.99**	**-76.84**	**Nana**	**Peru**	**3C**	
NWAO #	**-32.93**	**117.23**	**Narrogin**	**Australia**	**3C**	
OBN	**55.12**	**36.60**	**Obninsk**	**Russia**	**3C**	
OGS	27.05	142.20	Ogasawara	Japan	3C	
PFO	**33.61**	**-116.45**	**Pinon Flat**	**U.S.A.**	**3C**	
PMG #	**-9.41**	**147.15**	**Port Moresby**	**New Guinea**	**3C**	
PTGA #	**-.73**	**-59.97**	**Pitinga**	**Brazil**	**3C**	
RAR #	**-21.21**	**-159.77**	**Rarotonga**	**Cook Islands**	**3C**	
RPN	**-27.13**	**-109.33**	**Rapanui**	**Chile**	**3C**	
SADO	**44.77**	**-79.14**	**Sadowa**	**Canada**	**3C**	
SDV #	**8.88**	**-70.63**	**Santo Domingo**	**Venezuela**	**3C**	
SFJ #	**67.00**	**-50.62**	**Sondre Stromfjord**	**Greenland**	**3C**	
SHK	34.53	132.68	Shiraki	Japan	3C	
SNZO #	-41.31	174.70	South Karori	New Zealand	3C	
SPITS	**78.18**	**16.37**	**Spitsbergen Array**	**Norway**	**Array**	**9**
SUR	**-32.38**	**20.81**	**Sutherland**	**South Africa**	**3C**	
TKL	**35.66**	**-83.77**	**Tuckaleechee Caverns**	**U.S.A.**	**3C**	
TSK	36.21	140.11	Tsukuba	Japan	3C	
TSUM #	**-19.20**	**17.58**	**Tsumeb**	**Namibia**	**3C**	
ULN	47.87	107.05	Ulaanbaatar	Mongolia	3C	
VRAC	**49.31**	**16.59**	**Vranov**	**Czech Republic**	**3C**	

Bold type = IMS station; normal type = temporary substitute for IMS station.
* If present, indicates new station added during the period of this report. New stations are excluded from analysis.
# Accessed by modem dialup. Not normally used at the present time.

Table 3: Acoustic stations

Code	Lat.	Lon.	Name	Country	Station type	# of elements
ASC19	-7.82	-14.60	Ascension Island	U.S.A.	hydroacoustic	1
ASC21	-7.99	-14.49	Ascension Island	U.S.A.	hydroacoustic	1
ASC26	-7.94	-14.62	Ascension Island	U.S.A.	hydroacoustic	1
ASC27	-7.85	-14.37	Ascension Island	U.S.A.	hydroacoustic	1
ASC29	-7.95	-14.27	Ascension Island	U.S.A.	hydroacoustic	1
LSAR *	35.87	-106.33	Los Alamos, New Mex.	U.S.A.	infrasound	4
PSUR	36.30	-122.39	Point Sur, California	U.S.A.	hydroacoustic	1
SGAR *	37.02	-113.62	St. George, Utah	U.S.A.	infrasound	4
TXIAR *	29.33	-103.67	TXAR array, Texas	U.S.A.	infrasound	3
VIB	53.25	-132.54	Van Inlet	Canada	seismic T	1
WAKE	19.27	166.62	Wake Island	U.S.A.	hydroacoustic	1
WRAI *	-19.94	134.23	Warramunga	Australia	infrasound	7

* Infrasound stations are not yet included in standard IDC processing.

Table 4: Radionuclide stations

Code	Lat.	Lon.	Name	Country	Sample type *
AR001 #	-34.00	-58.00	Buenos Aires	Argentina	P
AU001	-37.45	144.58	Melbourne	Australia	P
CA001	45.30	-75.70	Ottawa	Canada	P
CA002	49.26	-123.25	Vancouver	Canada	P
CA003	74.70	-94.90	Resolute	Canada	P
CA004	62.45	-114.48	Yellowknife	Canada	P
CA005	47.00	-53.00	St. John's	Canada	P
DE002	47.92	7.91	Schauinsland	Germany	P
FI001	60.21	25.06	Helsinki	Finland	P
KW001	29.00	48.00	Kuwait City	Kuwait	P
NZ001	-35.12	173.27	Kaitaia	New Zealand	P
NZ002	-21.25	-159.75	Rarotonga	New Zealand	P
NZ003	-42.72	170.97	Hokitika	New Zealand	P
RU001	44.00	132.00	Ussuriysk	Russia	G&P
SE001	59.00	18.00	Stockholm	Sweden	G&P
UK001	51.50	-1.50	Chilton	England	P
US001	38.00	-78.00	Charlottesville	U.S.A.	P

* P = particulate; G = Xenon gas
# New station, added during the period of this report

Figure 5 and Table 5 show the status this period of the dedicated communication link segments from the NDCs that terminate at the IDC. Uptime percentages are simple averages based on daily sampling. For rare days on which no link status information is available, such as when a problem occurs with the monitoring system at the IDC, the affected links are assumed to have been up 100% of those days. Several of the links are backed up by the Internet, which takes over when the dedicated link goes down, but there is currently no means of accounting for this rerouting in Figure 5 and Table 5. The numbers for RUS_NDC are probably poorer than they should be, because the IDC was unable to effectively monitor this link until the telecommunications provider was changed and appropriate software modifications made at the end of March this year.

Following a power conditioner failure in the IDC computer room on December 20, the router serving the CAN_NDC and CHN_NDC links failed to come back up. The problem was noticed and remedied about 13 hours later, but the outages do not appear in Figure 5 due to the way the uptime monitor functions. Most of the data affected by the AUS_NDC link outage on January 4 were acquired in time for IDC processing with the aid of Internet rerouting (An exception was ASAR, which was affected by other problems). An alternate routing for continuous transmission of ABKT waveforms has not yet been established, since the RUS_OME link was discontinued in late September. Station operators report that the main sources of problems are with communications between Ashgabat, Turkmenistan and Obninsk.

Table 5: Communication link performance since 96/01/01

Origin	Baud Rate	Uptime (kbit/sec)	Previous Avg (%)
AUS_NDC	19.2	98.1	92.8
CAN_NDC	56.0	100.0	99.6
CHN_NDC	56.0	98.2	94.0
FRA_NDC	56.0	100.0	99.5
JPN_NDC	64.0	100.0	99.9
NOR_NDC	256.0	99.7	98.5
PNT_SUR *	9.6	89.0	92.1
RUS_NDC	64.0	100.0	91.1
USA_NDC	1500.0	99.9	99.2

* Link established subsequent to 96/01/01.

Primary station capability is presented in Figure 6. Station capability is normally estimated automatically once each day, 6 to 10 hours after the end of the day (UTC) and therefore does not include data that arrive at the IDC after that. For arrays, the station capability is based on the ratio of theoretical signal gain with channels actually available to the signal gain expected if all channels were available. For 3-component stations, full capability indicates that all 3 channels were operational; partial means the vertical and one horizontal; and low, one channel. Each section of a stacked bar indicates the percentage of the reporting period for which the respective capability was met. Because the plotted values are computed at the tail end of the data stream (i.e, at the IDC), they represent the culmination of all factors affecting data flow from the station.

Problems with primary station capability are often caused by failures of communications infrastructure, I upstream from the dedicated links into the IDC. Other common causes include problems with site hardware, power supply, or data transmission software.

Upstream communications problems were responsible for most of the lost station capability this period, including BOSA. See above under communications for the situation with ABKT. *On January 11, the last day of this period, a major satellite failure cut off all data flow from MNV. The station is not expected to become available again to the IDC for at least several weeks. The IDC began receiving data again from NRI and KBZ for the first time in 4 and 6 months, respectively, following instrument repairs. Replacement of modems in China produced a modest improvement in HIA capability. Problems related to fiber optic cabling and/or modems make waveforms unavailable much of the time from certain elements at TXAR/TXIAR and NORES.* LSAR and SGAR are usually non-capable part of each day, because data for these stations is forwarded to the IDC about one day behind real time.

Figure 7 shows the percentage of days during which auxiliary data were available to the IDC as determined by an automatic polling process that interrogates the stations once each day. The polling process continues to query a station that has been excluded from use in event formation as a means of determining when/if the station can be returned to active status. Data availability has been historically unavailable from JTS. ISG has been unusable since August 13 due to a malfunctioning data logger clock. *Renewed access of MSEY has been arranged, but the IDC is attempting to confirm calibration changes, before resuming requests.* FITZ has been down since November 30 because of a failed generator. NEW data have been unavailable since the station went down on November 27. *However, the satellite failure which severed the link from MNV has also rendered not only NEW but also the two other USNSN auxiliary stations used by the IDC, ALQ and ELK, inaccessible until an unknown date. ULN has become unavailable, until funding can be secured to re-establish local communications.*

Figure 8 shows the percentages of requests for auxiliary data that completed successfully for actual events in the AEL.

Data availability from the radionuclide network is reflected by the number of samples received at the IDC versus the expected frequency of receipt (Table 6). Numbers of samples are based on collection stop dates within the report period. The timeliness of notification from the IDC to station personnel regarding unreceived data is, by convention, about the same as the expected frequency of receipt. *The absence of 2 samples from the new station, AR001, reflect the fact that it became operational half way through the period. The number of reviewed particulate spectra shown for RU001 in Table 6 of the last report was incorrect. The correct number was 13, not 0.*

Table 6: Numbers of radionuclide spectra reviewed and released

Code	Sample type *	Expected frequency	Samples received	Comments
AR001	P	weekly	2	temporary change in operational procedures
AU001	P	5x week	16	long sampling time
CA001	P	weekly	4	
CA002	P	daily	27	data acquisition/transfer difficulties
CA003	P	biweekly	2	received late long decay time
CA004	P	biweekly	1	received late long decay time
CA005	P	monthly	1	long sampling time
DE002	P	weekly	4	
FI001	P	weekly	4	
KW001	P	daily	25	temporary change in operational procedures missing spectra
NZ001	P	weekly	0	temporary change in operational procedures
NZ002	P	weekly	0	temporary change in operational procedures
NZ003	P	weekly	0	temporary change in operational procedures
RU001	P	daily	2	data acquisition/transfer difficulties
RU001	G	2x/week	0	data acquisition/transfer difficulties
SE001	P	5x/week	13	long sampling time long decay time
SE001	G	2x/week	2	missing spectra
UK001	P	weekly	4	
US001	P	daily	28	

* P = particulate; G = Xenon gas

Rapid availability of data is critical to the monitoring mission of the prototype IDC System. Figure 9 shows estimates of the timeliness of receipt of *continuous* data at the IDC. These are based on comparison of the end times and load dates of processing interval records in the IDC database and may overestimate the actual time delay before which data were available. Nevertheless, Figure 9 indicates which stations normally contribute data in time to be used for preparing the automatic event lists: AEL (1 hour), ABEL (4 hours) and DEL (10 hours). The DEL is used by analysts as a basis for REB formation. *Figure 9 now includes infrasound data. As mentioned with regard to the station capability figure, LSAR and SGAR are, in practice, sent a day behind real time.*

Other problems with stations and communications are shown in Table 7.

Table 7: Technical problems affecting station data

Station	From	To	Problem
AAE	96/06/08		Timing error
ABKT	96/09/07		Data not available during comm reconfig
ARCES	96/05/31		Noisy channel(s)
ARU	96/12/12	96/12/18	Data not available; disk full at site
ARU	97/01/05		Station DRM not responding
ASAR	97/01/04	97/01/05	Data not available
ASAR	97/01/06	97/01/06	Data lost due to storms at NDC
ASCH stations	96/09/18		Calibration; also, cabling problems cause outages
All JPN auxil stn	97/01/11		Data not available
All USA_NDC stns	97/01/09	97/01/09	Problem or maintenance at NDC
BBB	96/12/26	97/01/02	Station down
BJT	96/09/23	96/12/24	Variable data availability
BOSA	96/12/17		Data not available
CAN auxil. stns	96/08/19		Problem accessing netw by established address
CMAR	96/12/18		Calibration error
CPUP	96/12/03	96/12/16	Communications failure at site
CPUP	96/12/20	96/12/25	Station down; power failure
CPUP	97/01/03		Data not available
DAV	96/04/09		Long-term problem with phone lines
DBIC	97/01/03	97/01/07	Corrupt data buffer at NDC
EKA	96/12/24		Communications failure
ELK	95/07/25		Calibration error
FITZ	96/11/30		Station down
GERES	97/01/05	97/01/05	Software failure at nor_NDC; data lost
HIA	96/04/10		Data not available

Table 7: Technical problems affecting station data *(Continued)*

Station	From	To	Problem
HIA	96/08/19		Corrupt frames; connections rejected by IDC
ISG	96/08/13	96/12/19	Timing error
JPN auxil data	96/09/13		DRM problem
JTS	96/05/16		Data requests failing
KBZ	96/06/25		Data not available
KIEV	96/04/20		Long-term problem with phone lines
KIEV	96/05/17		Data requests failing
KVAR	95/05/25		Anomalous amplitudes
KVAR	96/08/15		Variable data availability
LSAR, SGAR	97/01/05		Communications failure
LSZ	95/11/22		Long-term problem with phone lines
MLR	96/12/24	97/01/03	Communications failure
MLR	97/01/01		DRM problem
MNV	96/08/16		low amplitudes
MNV	96/08/30	96/12/17	Bad data; faulty equipment at site
MNV	97/01/11		Data not available
MSEY	96/05/10		Data not available
NEW	96/11/27		Data not available
NNA	96/07/05	96/12/30	Data not available
NORES	96/05/14		Array partially mission capable
NRI	96/08/26		Data not available
NZL01, 06	96/12/31		Communications failure?
PARD	97/01/09		Data not available
PDAR	96/12/19	96/12/23	IDC DLMan problem; data rejected
PDAR	96/12/26		Array sometimes partially mission capable
PDY	97/01/07		Station down for maintenance
PFO	97/01/06		Station drm not responding
PLCA	97/01/04		Data not available
PTGA	96/05/06		Connection cannot be completed
RAR	96/06/08		Data not avail.; comm protocol error
RPN	97/01/03	97/01/08	Site reachable, but data not available
RPN	97/01/09		Communications failure
SDV	95/09/13		Long-term problem with phone lines
SPITS	96/11/11		Six channels unavailable
SUR	97/01/05	97/01/08	Software error at station DRM host
TKL	95/12/28		AutoDRM problem; data incomplete
TXAR	96/12/10		Scheduled maintenance: some down time
TXAR infrasonic	96/07/09		Array partially or non capable; TXI01 outages
ULN	96/12/05		Comm line turned off in mongolia
VNDA	96/12/10	96/12/17	Station down; power failure
VNDA	96/12/10	96/12/20	Data not available
WAKE	97/01/08		Communications failure
ZAL	96/12/01		Variable data availability

B. IDC Facility and Logistical Factors

Facility operation was normal.

C. IDC Hardware Infrastructure

Several significant hardware outages affected Operations this period. All systems in the IDC computer room went down for several hours on December 20 at 07:15 UT due to a failed power conditioner. Later that day, near midnight, the disk drive on the lif *forwarder crashed and was replaced by about 03:00 UT. The forwarding machine,* lenny, *was taken down for three hours on December 28 to replace a hard drive shoebox. The IDC phone system was taken down 5 hours on January 8 at 22:00 UT for maintenance.*

The failure rate of the server, bigbyte, *has decreased. However, tapes continue to drop off line from time to time. It has been noticed that the machine hangs, when its Exabyte drive is used. Therefore, use of the drive has been stopped.* In an effort to make waveforms from prior to May 5, 1996 more readily available while problems are worked out of the new system, the old mass store has been reinstated. However, users should be aware that this system will always experience the problems which prompted its replacement.

D. IDC Software Infrastructure

Figure 10 shows the load on the operational database during this period. Daily peaks in connections coincide with heavy database usage during business hours at the IDC.

The mass storage software continues to cause some problems with waveform archiving and access. Some data requests cause *bigbyte* to take one or more tape volumes off line. This is being worked on by the vendor.

The process of upgrading nodes on the IDC LAN to Solaris 2.5 continues. Although Solaris 2.5 has now been installed on most of the computers critical to operations, a few notable exceptions remain: *ndegei*, the main NFS server; *mimer*, the e-mail exchange host for the cdidc.org domain; and *seismo*, the external e-mail server.

E. IDC Seismic Data Processing

Data Import and Export

Table 8 shows the volume of waveform data received at the IDC during this period.

Table 8: Volume of data received at the IDC by station network

Network	Current (MB/day)	Previous Average (MB/day)
Primary	2709.1	2480.2
Auxiliary	167.6	234.1
Hydroacoustic	299.1	183.8
Infrasound	64.1	44.6

Some old waveform data have been made available for export again from the old epoch mass storage device. The epoch online archive is periodically replaced with more recent data. GSETT-3 data not in the mass stores are stored offline.

Table 9 shows the numbers of bulletins and waveforms exported from the IDC by standard subscriptions during the current period. *Distribution times for daily REBs ranged from 1.9 to 5.8 days after the ends of datadays and averaged 3.8 days. Two of the longest distribution delays occurred for the December 12 and 25 REBs, both resulting from temporary difficulties with a new subscription system installed this period (See "System Changes" below). Other initial problems with the new subscription system included some bulletins distributed with some or all information absent from the mail header subject lines. All these problems have been corrected.*

Table 9: IDC subscription data exports

Product	Schedule	Category	Subscriptions	
			Complete	Constrained
AEL	Daily	Bulletin	7	4
ABEL	Daily	Bulletin	6	2
REB	Daily	Bulletin	50	17
data	Continuous	Waveforms	27	
Station Status	Daily	System Report	43	
Channel Status	Daily	System Report	4	
Comm Status	Daily	System Report	31	
Extended Comm Status	Daily	System Report	2	

The IDC currently forwards continuous waveform data from primary stations to FRA_NDC, RUS_NDC, and USA_NDC. The progress of this system throughout the report period is depicted in Figure 11. Each shaded brick in Figure 11 represents the ratio of the volume exported from the IDC for the given data stream over an interval of time to the volume received at the IDC during the same interval. Diagonal shading indicates a greater volume forwarded than received during catch-up from delays either in the forwarding system or somewhere upstream.

Because of the difficulty in monitoring data packets with continuously varying compression ratios, a day of 100% forwarding (white box) does not necessarily represent 100% of the data for that day. It means only that the same amount of data received during that time was also forwarded during the same time. Failures of forwarding to the FRA_NDC are, for the most part, caused by rejection at the NDC.

Several problems with IDC software have historically interfered with the forwarding process. Flaws in AlphaDLHeap sometimes stop the program from writing to the export buffers, until a staff person becomes aware of the problem, cleans out any corrupted buffers, and restarts the program. While AlphaDLHeap is either down or unable for some reason to connect to one or more DLMans, it has no way to recover data being received at the IDC by operational DLMans. Software developers are working on a solution to this in which the forwarding system can recognize and re-attempt to forward data that it missed on the first pass.

In the mean time, partial remedies to these problems came on December 17. First, improvements were made to the processes which automatically restart failed DLMans, AlphaDLHeaps, and AlphaForwards following server reboots. The new versions of forwarding software announced in "System Changes" also helped. These repairs may explain the general reduction in forwarding gaps (scattered gray bricks) in Figure 11 compared with this figure in previous reports.

Some unusual problems adversely affected forwarding this period. On December 20/21, a disk failure on the heap server, lif, *caused a 6 hour forwarding delay for all data streams. It also resulted in the loss of all statistics for that machine from part of December 16 through December 20. Therefore, the zone of black bricks for those days in Figure 11 does not accurately reflect the actual forwarding status. Other forwarding problems resulted on the same day because of the power conditioner failure. Delays on December 28 were due to the hardware maintenance outage of* lenny. *A problem with* laufey *on January 8 caused delays forwarding its associated data streams.*

An AutoDRM-based message system at the IDC receives, processes, and responds to all requests for waveforms or IDC products submitted through GSE formatted e-mail messages. Volumes of data exported from the IDC to various countries by AutoDRM are given in Table 10.

Table 10: IDC data export by AutoDRM

Country	GSE2.0 Messages	Message Volume (Mbyte)
Canada	3	0.145
China	62	23.258
France	345	23.544
Germany	2	0.189
Israel	10	43.405
Russian Federation	7	6.707
Turkey	3	0.039
United Kingdom	104	19.434
United States	2039	220.972
Total	2575	337.691

The progress and timeliness of processing and responding to GSE requests represent critical elements of a functional IDC. Because waveform requests often take relatively long times to process and because of the ongoing problems with the mass storage hardware and software, the message system has been designed to handle waveform versus non-waveform requests independently from each other. This prevents problems with mass store retrieval from holding up processing of non-waveform messages in the request queue. It also makes it necessary to distinguish between the two types of requests to effectively evaluate overall performance of the message system.

Table 11 tracks the progress of message processing on waveform requests for this period by date, and Table 12 summarizes the timeliness of responses to requests over the whole period. Analogous results for non-waveform requests are shown in Tables 13 and 14. Tallies represent numbers of requests, except where noted. During the course of processing, a request may occupy different states, but the tallies in Tables 11 through 14 show only the "final" states on any given day. "Successfully processed" means the ratio of requests handled without IDC errors to the total number of requests. Therefore, format errors and lack of data availability are regarded by this definition as successes.

Table 11: Message system performance for waveform requests as of 97/01/21 *

Date	Data exported	Format error	No data	Offline	Standby	Unknown	Total	Successfully processed (%)
96/12/15	1	0	0	0	0	0	1	100
96/12/16	146	0	25	0	0	0	171	100
96/12/17	33	0	50	2	0	0	85	97
96/12/18	68	0	4	0	0	0	72	100
96/12/19	67	0	67	0	0	0	134	100
96/12/20	51	0	33	0	1	0	85	98
96/12/21	1	0	0	0	0	0	1	100
96/12/22	1	0	0	0	0	0	1	100
96/12/23	76	0	124	0	0	0	200	100
96/12/24	82	0	99	0	0	0	181	100
96/12/25	1	0	0	0	0	0	1	100
96/12/26	1	0	0	0	0	0	1	100
96/12/27	101	0	140	0	0	0	241	100
96/12/28	1	0	0	1	0	0	2	50
96/12/29	25	0	7	0	0	0	32	100
96/12/30	7	0	7	0	0	0	14	100
96/12/31	69	0	111	15	0	0	195	92
97/01/01	1	0	0	0	0	0	1	100
97/01/02	78	0	91	0	0	0	169	100
97/01/03	158	0	73	0	0	0	231	100
97/01/04	1	0	0	0	0	0	1	100
97/01/05	1	0	0	0	0	0	1	100
97/01/06	49	0	0	0	0	0	49	100
97/01/07	124	0	19	0	0	0	143	100
97/01/08	91	0	7	6	0	0	104	94
97/01/09	172	0	9	6	0	0	187	96
97/01/10	121	0	5	0	0	0	126	100
97/01/11	26	0	1	0	0	0	27	100
28 day total	1553	0	872	30	1	0	2456	99

* Status categories have the following meanings:
Format error: error in request message
No data: data not present at the IDC
Offline: waveforms accessible only on tapes or epoch platters
Standby: Mass store or LAN problem at IDC caused a retrieval to fail, and request was re-queued

Table 12: IDC response timeliness for waveform requests as of 97/01/21

Response Time	Data exported	Format error	No Data	Offline	Standby	Unknown	Total
< 1 minute	441		189	24	1		655
< 1 hour	923		650	5			1578
< 1 day	110		33	1			144
> 1 day	79						79
No Response							
28 day total	1553	0	872	30	1	0	2456

Table 13: Message system performance for non-waveform requests as of 97/01/21 *

Date	Data exported	Format error	No data	Unknown	Total	Successfully processed (%)
96/12/15	13	0	0	0	13	100
96/12/16	13	0	0	0	13	100
96/12/17	15	0	0	0	15	100
96/12/18	16	0	0	0	16	100
96/12/19	17	0	0	0	17	100
96/12/20	20	0	2	0	22	100
96/12/21	13	0	0	0	13	100
96/12/22	13	0	0	0	13	100
96/12/23	15	0	0	0	15	100
96/12/24	15	0	1	0	16	100
96/12/25	14	0	0	0	14	100
96/12/26	13	0	0	0	13	100
96/12/27	13	0	0	0	13	100
96/12/28	32	1	2	0	35	100
96/12/29	16	0	0	0	16	100
96/12/30	12	0	0	0	12	100
96/12/31	14	0	1	0	15	100
97/01/01	12	0	0	0	12	100
97/01/02	30	0	5	0	35	100
97/01/03	13	0	1	0	14	100
97/01/04	14	0	0	0	14	100
97/01/05	14	0	0	0	14	100
97/01/06	19	0	0	0	19	100
97/01/07	14	0	1	0	15	100
97/01/08	15	0	0	0	15	100
97/01/09	16	0	0	0	16	100
97/01/10	14	0	0	0	14	100
97/01/11	7	0	0	0	7	100
28 day total	432	1	13	0	446	100

* Status categories have the following meanings:
Format error: error in request message
No data: data not present at the IDC

Table 14: IDC response timeliness for non-waveform requests as of 97/01/21

Response Time	Data exported	Format error	No Data	Unknown	Total
< 1 minute	395	1	10		406
< 1 hour	19				19
< 1 day	18		3		21
> 1 day					
No Response					
28 day total	432	1	13	0	446

Automatic Processing

The IDC strives to complete the AEL and ABEL within 1 hour and 4 hours, respectively, of event origin time. Actual completion times of 90% of the events for each event list are plotted against target times in Figure 12, and brief explanations for event list delays are given in Table 15. *Processing delays this period resulted primarily from cooling fan failures in two critical pipeline computers and a DNS error that prevented restarts of disk-loop managers. The impact of interprocess communication problems appears reduced. However, this is due to 1) the IDC staff having to take the pipeline down and restart it every 3 to 4 days, a process that can delay processing by anywhere from several minutes to around an hour, to prevent the crashing of ISIS and the CommAgents, and 2) much practice by pipeline personnel in recovering from the inevitable crashes which do occur.*

Table 15: Automatic processing: Data day outcomes

Date	Jdate	Problems	Outcome
96/12/15	1996350		
96/12/16	1996351		
96/12/17	1996352		
96/12/18	1996353		
96/12/19	1996354		
96/12/20	1996355	power conditioner failure	delayed ABEL
96/12/21	1996356		
96/12/22	1996357		
96/12/23	1996358	CommAgent-Pipeline hang	
96/12/24	1996359		
96/12/25	1996360	DNS file error prevented DLMan restart on *laufey*	delayed ABEL
96/12/26	1996361		
96/12/27	1996362	*shiva* and *lenny* failures	delayed ABEL
96/12/28	1996363	*shiva* and *lenny* maintenance	delayed ABEL
96/12/29	1996364		
96/12/30	1996365		
96/12/31	1996366		
97/01/01	1997001	WM-telnet and WM-GSEs failed to start	
97/01/02	1997002		
97/01/03	1997003	CommAgent-Pipeline hang, *lenny* maintenance	
97/01/04	1997004		
97/01/05	1997005		
97/01/06	1997006	several *ndegei* reboots due to NFS errors	
97/01/07	1997007		
97/01/08	1997008	*mimer* failure, *laufey* failure	
97/01/09	1997009		
97/01/10	1997010		
97/01/11	1997011		

Analyst Review

Figure 12 shows the time that events were saved in the REB database account relative to the event origin time. The IDC attempts to complete the Reviewed Event Bulletin (REB) within 2 to 4 days following the end of each data day, which can range from 48 to 96 hours after the event origin time.

The longest completion times for the REB are generally associated with Thursday through Saturday datadays, because no analysis is done on weekends. *Unusual delays occurred for December 25 as a result of reduced staffing during the Christmas holiday.*

F. System Changes to the Prototype IDC

In accordance with CCB approval, the IDC installed an entirely new subscription system on December 16. It is designed to meet GSETT-3 specifications and incorporates many improvements to the previous system. For example, immediate bulletins are now available, whereas only daily bulletins were available before. Except upon request, no product is sent for a constrained daily subscription on a given day, if no events satisfied the constraints. Also, simpler maintenance procedures should reduce delays in repairing failed subscriptions. Database entries and logging in the new system permit individual products to be validated by tracing them directly back to the originating subscription request. This also aids in troubleshooting the system.

Several changes were made to the forwarding system. New versions of AlphaDLHeap and AlphaForward installed on December 17 provide improved handling of bad packet sizes, added packet buffering for reattempting forwarding after lost connections have been re-established, and other miscellaneous changes. Another upgrade to these programs on January 8 provides logic enabling them to recognize certain common signal errors and to prevent such errors from sending processes into infinite loops. A new program called HeapCheck, which facilitates the examination of forwarding heap files, was installed on December 20.

Some IDC-developed code was installed early this period to enable analysts to allocate their time blocks through ARS. This means that the allocations are now stored on line, which permits automatic post-analysis processing. It also makes the allocations accessible to anyone with IDC database access.

One type of automated post-analysis processing was implemented this period. A DFX patch was installed December 17 containing several modifications to support Recall Processing, which was then installed the next day into the Operations pipeline. Recall processing finds analyst-added phases and extracts the usual DFX features such as amplitude, period, SNR, azimuth, and slowness and uses the added amplitudes to recompute m_b *and ML magnitudes. The software skips several phases per day due to such things as data gaps, glitches, etc. so close to the arrivals that DFX has insufficient uninterrupted precursory data with which to make its measurements.*

A new version of Parse-data, which receives incoming data messages and writes them to the database, was installed on December 17. The new version provides more detailed logging of parsing failures.

An ARS patch installed January 7 fixed a problem which had been causing session crashes under certain display-change circumstances.

G. Principal Operational Problems

The principal problems currently affecting the quality and reliability of operations at the IDC are:

1. irregular data availability from some primary stations
2. reduced availability of experienced analysts for REB production
3. problems related to ISIS and CommAgent interprocess communication software
4. lack of access to some archived waveforms due to mass store failures

SEISMOLOGICAL SUMMARY

A. Station Processing

Primary Station Performance

Figure 13 shows the phase detection rate for primary stations, and Figure 14 shows phases detected but unassociated. Noise represents a significant percentage of the detections from most stations. All hydroacoustic detections are non-defining and therefore do not appear in these figures.

Auxiliary Station Performance

Phase detection performance at the IDC for the auxiliary stations is presented in Figures 15 and 16. The previous daily averages for MBC and PFO are excluded from Figure 15 because of their much larger values than for the other auxiliary stations. This is due to their primary network status prior to July 1. Arrays are not currently represented in Figures 15 and 16.

Supplementary Data Availability

Table 16 summarizes supplementary data received by the IDC from the 23 contributing countries and parsed into the IDC database since the start of GSETT-3. Norway and Finland submit supplementary data through the FIN_NDC. The IDC has had trouble with the process that parses supplementary data. Errors frequently occur when processing updates to previously reported events. The IDC has arranged with some countries to delete the previous solutions in advance to avoid this problem.

Table 16: Summary of supplementary data in the IDC database as of 97/01/13

Source	First	Last	Total # events	min ML	max ML
AUS_NDC	95/01/01	96/03/30	160	2.2	4.9
BGR_NDC	95/01/01	95/04/24	89	2.4 *	4.4 *
CAN_NDC	94/08/01	96/12/31	1104	1.4	6.3
CHE_NDC	94/01/17	96/12/25	62	2.5	4.6
CHN_NDC	95/01/01	96/09/30	7747	2.7	7.1
DEU_NDC	95/11/01	96/09/30	1239	1.5	5.9
DMK_NDC	95/05/30	95/11/30	3	3.0	4.1
ESP_NDC	93/05/01	96/10/31	2697	1.7	5.1
FIN_NDC	94/12/08	96/11/29	3555	1.1	5.4
FRA_NDC	93/06/01	96/11/29	1213	1.9	5.6
GBR_NDC	95/01/01	97/01/12	49	2.5	5.5
HUN_NDC	95/01/23	95/10/09	13	1.6	5.0
ISR_NDC	95/01/02	95/10/22	37	2.4	3.5
ITA_NDC	93/11/05	96/12/31	1627	2.0	6.2
JPN_NDC	94/01/31	96/12/30	24124	2.1	7.9
NZL_NDC	94/07/01	95/02/28	6242	3.0	6.8
PER_NDC	96/05/29	96/10/21	232	3.2 *	5.4 *
POL_NDC	95/01/01	95/12/31	461	2.0	3.9
ROM_NDC	95/01/02	97/01/01	379	2.5 *	5.1 *
RSA_NDC	95/01/02	96/07/31	1005	1.8	4.7
RUS_NDC	95/01/01	96/12/31	4293	2.6 *	5.1 *
SWE_NDC	95/01/11	96/03/21	91	N/A	N/A
USA_NDC	95/01/01	96/12/22	4816	2.1	6.0

* Duration magnitudes are shown for BGR, PER, and ROM NDCs; body-wave magnitudes for RUS_NDC.

Automatic Signal Processing

Changes to phase timing, identification and association with events take up much of an analyst's time, and an important objective of automatic processing is to minimize the number of changes required. Table 17 shows some of the changes to arrivals during the analyst review as reported in the Reviewed Event Bulletin (REB). The percentages of all phase changes are relative to the total number of defining phases in the REB, except for retimed phases, which are relative to the number of time-defining phases. Numbers for the current quarter do not include the current period. Numbers of disassociated phases are unavailable for the second and third quarters at this time because of memory overruns associated with the software.

Table 17: Changes of phases during the analyst review

Type of Change	Current		1996 Q1		1996 Q2		1996 Q3		1996 Q4	
	# of Phases	% of Def	#	%	#	%	#	%	#	%
Unmodified	5835	31.7	16854	19.3	24230	26.4	22377	30.4	19468	35.0
Retimed	6935	37.7	32925	37.8	30758	33.6	22743	30.9	17400	31.3
Added	3315	18.0	28837	33.1	26740	29.2	19177	26.1	10354	18.6
Associated	8419	45.8	53305	61.2	49249	53.7	37626	51.1	25923	46.6
Renamed	5511	30.0	22481	25.8	23319	25.4	19426	26.4	16276	29.2
Disassociated	24870	135.2	96743	111.0	N/A	N/A	N/A	N/A	72694	130.6

B. Event Bulletins

Automatic Event Processing

Table 18 shows the numbers of events in automatic lists and the reviewed bulletin. Percentages are normalized to the number of events in the REB. The event definition criteria are more restrictive for the REB than for the automatic event lists. *A total of 1556 events (56 per day) were in the Reviewed Event Bulletin (REB) for this period. Of these, 2% were added by analysts, 58% included auxiliary arrivals, and 19% included hydroacoustic data.* The percent of events added by analysts is unrealistically optimistic, since most days are not currently scanned for missed events.

Table 18: Numbers of events in the various bulletins										
Category	Current		1996 Q1		1996 Q2		1996 Q3		1996 Q4	
	# Events	% REB	#	%	#	%	#	%	#	%
AEL (all)	4060	260.9	10516	151.1	12227	186.0	10908	206.2	10572	222.8
AEL (>= 3 stations)	3040	195.4	7955	114.3	8258	125.7	7504	141.9	7710	162.5
ABEL (all)	3163	203.3	10938	157.1	12007	182.7	9389	177.5	8819	185.9
ABEL (>= 3 stations)	2650	170.3	8787	126.2	8733	132.9	7393	139.8	7119	150.1
DEL (all)	3211	206.4	10876	156.2	12058	183.5	9618	181.8	9022	190.2
DEL (>= 3 stations)	2784	178.9	9340	134.2	9596	146.0	7968	150.7	7653	161.3
REB (all; >= 3 stations)	1556	100.0	6961	100.0	6572	100.0	5289	100.0	4744	100.0
With Auxiliary Data	904	58.1	4127	59.3	4746	72.2	4065	76.9	2934	61.8
With Hydro Data	296	19.0	0	0.0	819	12.5	1385	26.2	1375	29.0
With Seismic T	0	0.0	1	0.0	1	0.0	0	0.0	1	0.0
Added	29	1.9	1997	28.7	864	13.1	196	3.7	128	2.7
Rejected	1438	92.4	4893	70.3	5017	76.3	3523	66.6	3420	72.1
Unmodified	5	0.3	0	0.0	0	0.0	2	0.0	5	0.1
Split Repaired	175	11.2	956	13.7	1063	16.2	685	13.0	667	14.1

Table 19 shows the changes of epicenters between the automatic DEL and the Reviewed Event Bulletin. The greatest number of changes are typically for those events with the nearest station more than 2000 km distant and involve changes of more than 50 km.

Table 19: Changes of hypocenters between the DEL and REB											
Change	Nearest	Current		1996 Q1		1996 Q2		1996 Q3		1996 Q4	
(km)	station (km)	# Events	% REB	#	%	#	%	#	%	#	%
Epicenter: < 10	< 200	2	0.1	20	0.3	26	0.4	14	0.3	12	0.3
Epicenter: 10-50	< 200	5	0.3	42	0.6	60	0.9	48	0.9	36	0.8
Epicenter: > 50	< 200	4	0.3	14	0.2	18	0.3	14	0.3	14	0.3
Epicenter: < 10	200-2000	44	2.8	155	2.2	189	2.9	207	3.9	151	3.2
Epicenter: 10-50	200-2000	153	9.8	477	6.9	550	8.4	594	11.2	386	8.1
Epicenter: > 50	200-2000	169	10.9	529	7.6	783	11.9	613	11.6	483	10.2
Epicenter: < 10	> 2000	91	5.8	179	2.6	251	3.8	255	4.8	267	5.6
Epicenter: 10-50	> 2000	300	19.3	707	10.2	828	12.6	970	18.3	870	18.3
Epicenter: > 50	> 2000	759	48.8	2842	40.8	3002	45.7	2377	45.0	2396	50.5
Depth	< 200	6	0.4	28	0.4	44	0.7	28	0.5	37	0.8
Depth	200-2000	234	15.0	682	9.8	912	13.9	896	16.9	617	13.0
Depth	> 2000	703	45.2	2814	40.4	2755	41.9	2295	43.4	2137	45.1

Distribution of Epicenters

Figure 17 shows the global distribution of epicenters in the DEL for the current period with and without the constraint of at least 6 defining phases per event, and Figure 18 shows the analogous maps for the REB. The epicenters outline the most active seismic regions. Events in the Fiji and Tonga Islands regions typically have the largest estimated uncertainties. Additional detail is provided in regional maps for the western Pacific, Europe, and western North and Central America (Figures 19 through 21).

Network Capability

This section discusses the theoretical detection capability of the primary seismic network for the *previous periods, October 20 through November 16 and November 17 through December 14, 1996* and considers events that may have been missed by the IDC. *The October-November period is included here due to an IDC database problem last period which prevented accessing the USGS data for preparation of the respective report.* Because of the uneven distribution of the primary stations, the network capability varies strongly world wide. Thus, the performance of the system should be evaluated against the predicted capability. Figures 22 and 23 show the predicted capability for the two report periods based on preliminary noise estimates of primary stations. It should be noted that these estimates are not very accurate, and improved estimates may change the results. The contours are adjusted by a constant factor to account for availability of data from each primary station.

The Quick Epicenter Determination (QED) of the U.S. Geological Survey (USGS) was the only global reference bulletin available at the time this report was prepared. The QED contains events determined with data from a variety of sources, including regional networks.

Figure 22 and 23 compare the REB to the QED based on the expected performance of the primary network. There were no events reported in the QED for either of these time periods having a > 90% probablity of detection by the GSETT-3/IMS network, which did not also appear in the REB (Table 20).

Table 20: Events in other bulletins but not in the REB
96/10/20 - 96/12/14 (two periods)

Date	Time	Latitude	Longitude	Depth (km)	m_b	Bulletin
No missed events.						

Depth Estimates

Figure 24 shows the distribution of focal depths in the REB that were unconstrained (free), constrained by ARS, constrained by the analyst or constrained using depth phases.

Figure 25 compares the IDC depth solutions that were unconstrained with QED (USGS) depths, both constrained and unconstrained. The largest discrepancies in focal depths between the bulletins tend to be among those events in the QED with depths constrained by geophysicists and those in the REB with unconstrained focal depths.

Event Definition

Distributions of the numbers of defining phases and stations used for event formation are shown in Figure 26.

Magnitude Estimates and Distributions

Table 21 summarizes the magnitudes calculated for the REB. The right-most column shows the number of events on a yearly basis, regardless of magnitude type. The last row gives averages since January 1, 1996. Body-wave magnitudes are unavailable for some events that do not have amplitudes calculated during automatic processing.

Table 21. Summary of magnitudes reported in the REB

Report period	m_b		ML		Ms		Total
	N/period	% of REB	N/period	% of REB	N/period	% of REB	N/year
Current reporting period	1488	95.6	517	33.2	139	8.9	20298
Last period	1601	93.6	501	29.3	139	8.1	22306
Average since 96/1/1	1712	90.5	688	36.4	161	8.5	24663

Figure 27 shows the recurrence rate distributions of body-wave magnitudes, m_b, and local magnitude, ML, from the current and previous periods for the global data set as well as m_b for four selected regions. Deviation at smaller magnitudes from an approximately linear trend is a rough indicator of the detection threshold for a given region. Cumulative distributions of m_b for the global data set are tabulated in Table 22.

Table 22: Cumulative m_b distribution

m_b	Current period		Last period		Total since 96/1/1	
	number	number/year	number	number/year	number	number/year
<3.0	1488	19411	1601	20885	21343	22337
3.0	1450	18915	1578	20585	21017	21996
3.1	1432	18680	1560	20350	20769	21736
3.2	1395	18198	1533	19998	20398	21348
3.3	1347	17572	1498	19541	19851	20775
3.4	1286	16776	1430	18654	19062	19950
3.5	1183	15432	1335	17415	17965	18801
3.6	1055	13762	1210	15784	16491	17259
3.7	924	12054	1055	13762	14626	15307
3.8	756	9862	867	11310	12487	13068
3.9	599	7814	681	8884	10281	10760
4.0	463	6040	519	6770	8169	8549
4.1	344	4487	394	5140	6302	6595
4.2	244	3183	281	3666	4691	4909
4.3	159	2074	201	2622	3451	3612
4.4	96	1252	138	1800	2431	2544
4.5	67	874	97	1265	1732	1813
4.6	51	665	75	978	1195	1251
4.7	32	417	52	678	845	884
4.8	23	300	33	430	596	624
4.9	18	235	22	287	447	468
5.0	15	196	18	235	342	358
5.1	12	157	12	157	235	246
5.2	8	104	7	91	157	164
5.3	5	65	5	65	103	108
5.4	4	52	2	26	79	83
5.5	2	26	1	13	48	50
5.6	2	26	0	0	24	25
5.7	0	0	0	0	13	14
5.8	0	0	0	0	8	8
5.9	0	0	0	0	2	2
6.0	0	0	0	0	1	1
6.1	0	0	0	0	1	1
6.2	0	0	0	0	1	1

The top two plots in Figure 28 compare the m_b and Ms values from the IDC with their counterparts from the QED of the National Earthquake Information Center of the U.S. Geological Survey. *The IDC m_b magnitudes are generally smaller than the QED values due to several factors. According to Murphy and Barker (Murphy, J. R., and B. W. Barker, An evaluation of the IDC/NEIS/m_b anomaly, Maxwell Technologies, Sept 1996.), the practice of correcting trace amplitudes for instrument response may account for most of this apparent discrepancy for small events (m_b < 5); the IDC is consistently applying the gain at the signal period whereas a number of stations reporting to NEIS appear to use the nominal gain at 1 Hz regardless of signal period. The combined effects of differences in attenuation correction factors-- Gutenberg-Richter at the NEIS and Veith-Clawson at the IDC-- and of differences in focal depths appear to contribute to a lesser degree to the m_b discrepancy. However, for deep events, these effects can be quite significant. Although m_b at IDC arrays might be lower than those at single stations, this appears to have only a marginal overall effect. Finally, the difference in m_b between NEIS and IDC is often more pronounced for large events (m_b > 5) than for smaller ones. This could be attributed to the narrow frequency band, 0.8-4.5 Hz, and short time window, 5 sec, employed for m_b amplitude measurements at the IDC.*

The lower two plots in Figure 28 compare ML and Ms values with m_b values, where all numbers are taken from the REB. Comparison of Ms with m_b shows a tendency for Ms < m_b for smaller events and the opposite for larger events. This is a normal relationship, because smaller sources have more of their energy in the pass-band used for m_b measurements. For larger events, body-wave magnitudes saturate, and, in large crustal events, surface waves will tend to dominate the wavetrain.

Table 23 shows the scatter in station magnitudes. Factors contributing to the deviations in Table 23 include errors in instrument calibration; lack of path, station and depth corrections; and uncorrectable seismological variations (directivity, focal mechanism, etc.). For many events, IDC magnitudes are poorly constrained due to lack of amplitude estimates caused by such factors as undetected LR phases, lack of amplitudes for analyst-added phases, etc.

Table 23: Scatter in station magnitudes

Magnitude	# of observations	σ (magnitude units)	% outside $2 \cdot \sigma$
ML	168	0.44	6.5
m_b	5481	0.36	7.1

Use of Stations in Bulletin Production

Heterogeneities in the geographical distributions of seismic events and stations contribute to variations among the stations in their use for event solutions. The effectiveness of processing at the IDC and operational factors, such as data availability, also contribute to variation among stations. Figures 29 and 30 show the fraction of all REB events during this period within different distance ranges from the primary and auxiliary stations, respectively, to which those stations contributed arrivals. *The figures now include associated but non-defining as well as defining phases. This allows the usage of hydroacoustic stations to be shown. An error in a parameter file for BORG which had been preventing automated detections for that station was discovered and corrected on January 8.*

C. Principal Seismological Problems

1. poor automatic phase identification for some stations
2. large scatter in magnitude estimates

CHANGES IN PERFORMANCE WITH TIME

Changes in the numbers of stations, NDCs providing supplementary data, and the results of station processing since the beginning of GSETT-3, Version 3 are shown in Figure 31. Changes in the results of event processing for the same time period are shown in Figure 32. Declines in the numbers of primary and auxiliary stations reflect changes toward IMS network configurations and removal of dialup stations from daily network status in IDC processing.

Installation of DFX and GA early this year produced a 40% drop in numbers of unassociated detections for primary stations compared with the high for GSETT-3, Version 3 and an 80% drop for auxiliary stations (Figure 31). The improved signal detection features of DFX and association capability of GA resulted in a 40% reduction, as a percentage of the REB, in the numbers of arrivals that analysts have had to retime and a 50% decrease in numbers of events they must add, since the Version 3 highs.

For the period beginning August 25, the number of phase detections increased again by 25% for the primary network and tripled for the auxiliary network (Figure 31). Correspondingly, analysts have had to add fewer phases but rename more as a percentage of the REB. There was also a marked increase in the numbers of automatically formed and analyst-modified events (Figure 32). These changes are believed to reflect the new detection thresholds for 3C stations installed that period, since the number of events reaching the REB remained about the same as for the previous period.

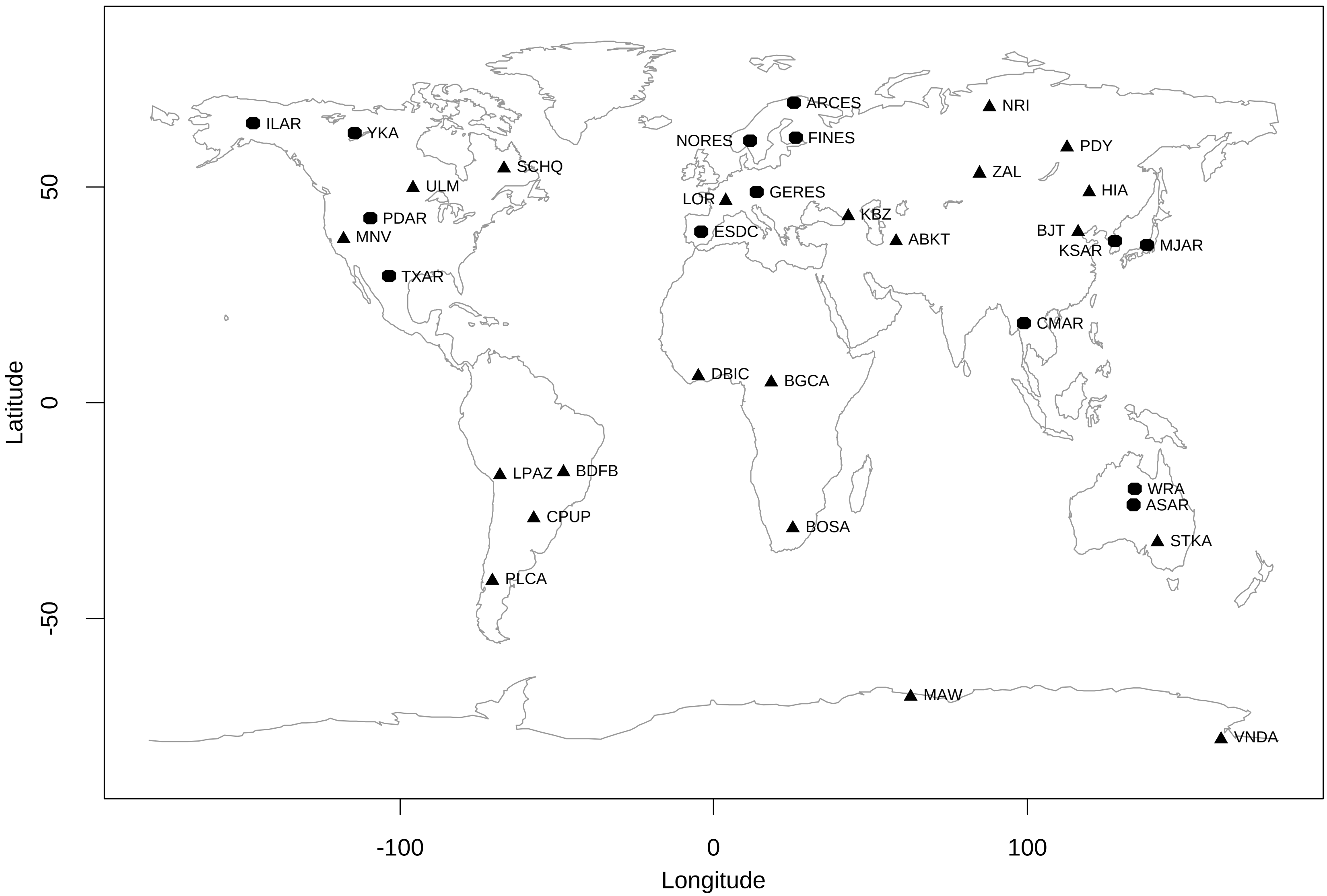


Figure 1. Geographical distribution of participating primary seismic stations. Array stations and 3-C stations are marked as circles and triangles, respectively.

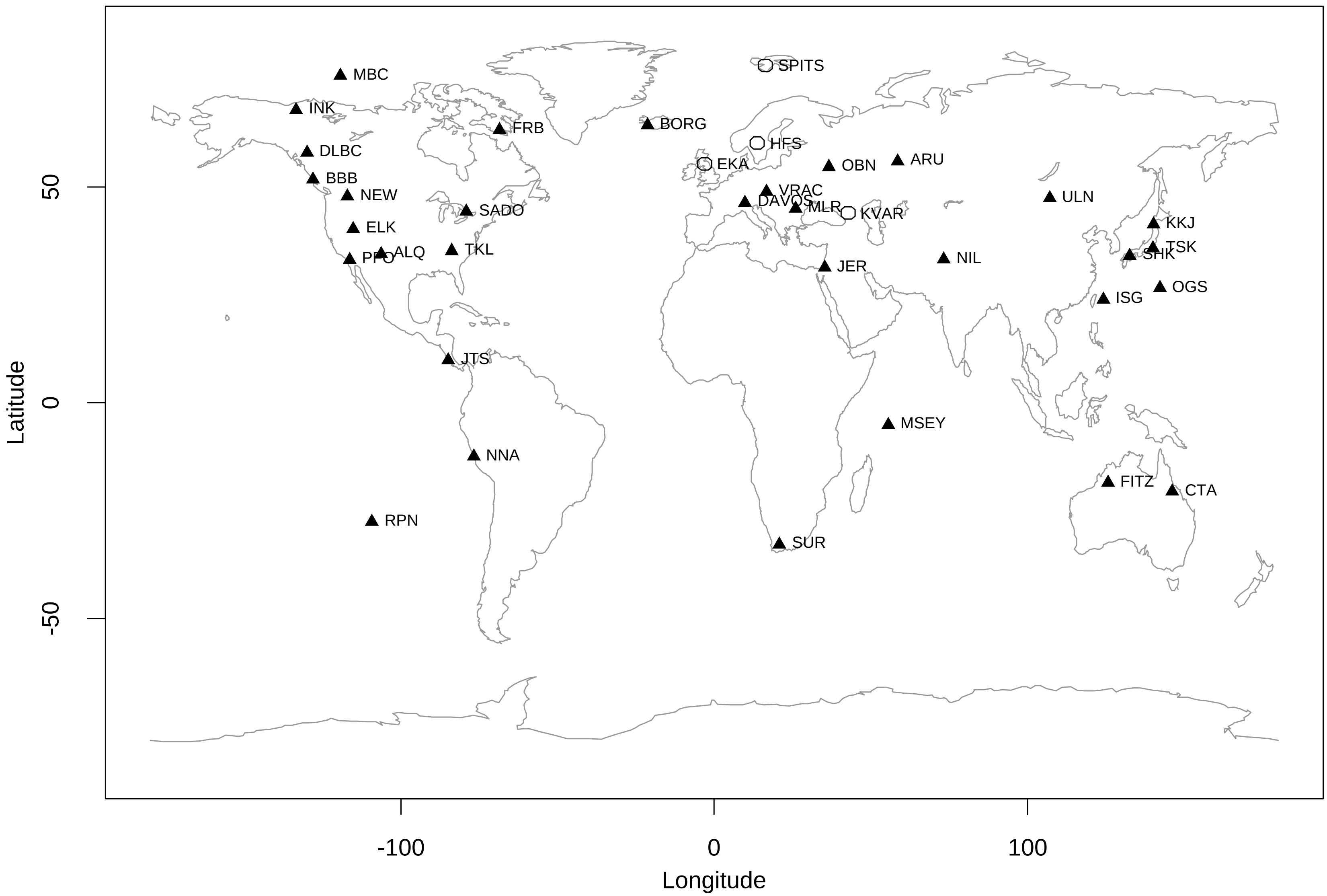


Figure 2. Current auxiliary seismic stations. Arrays and 3-C stations are marked as circles and triangles, respectively.

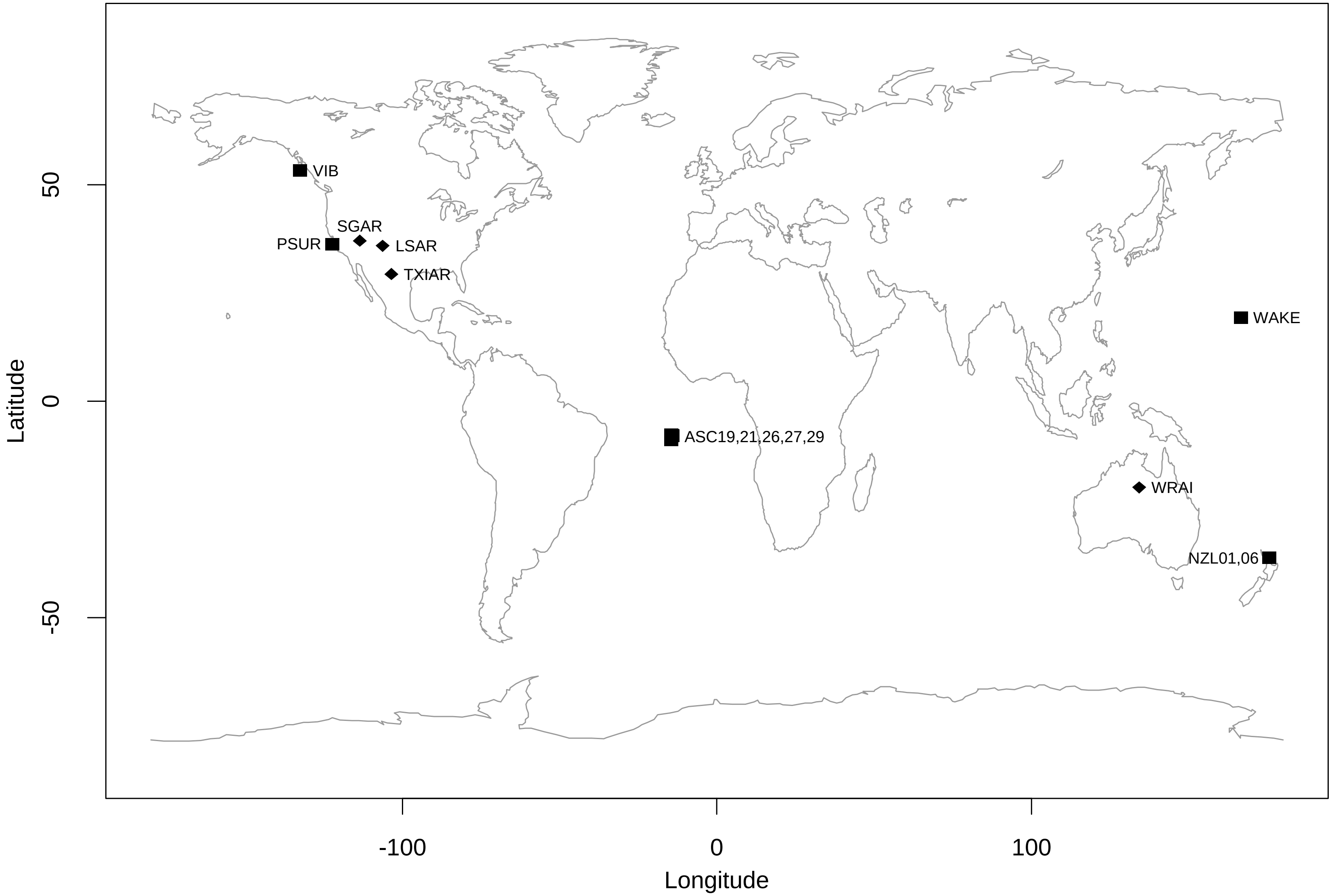


Figure 3. Hydroacoustic (squares) and infrasound (diamonds) stations for which the IDC is currently receiving data.

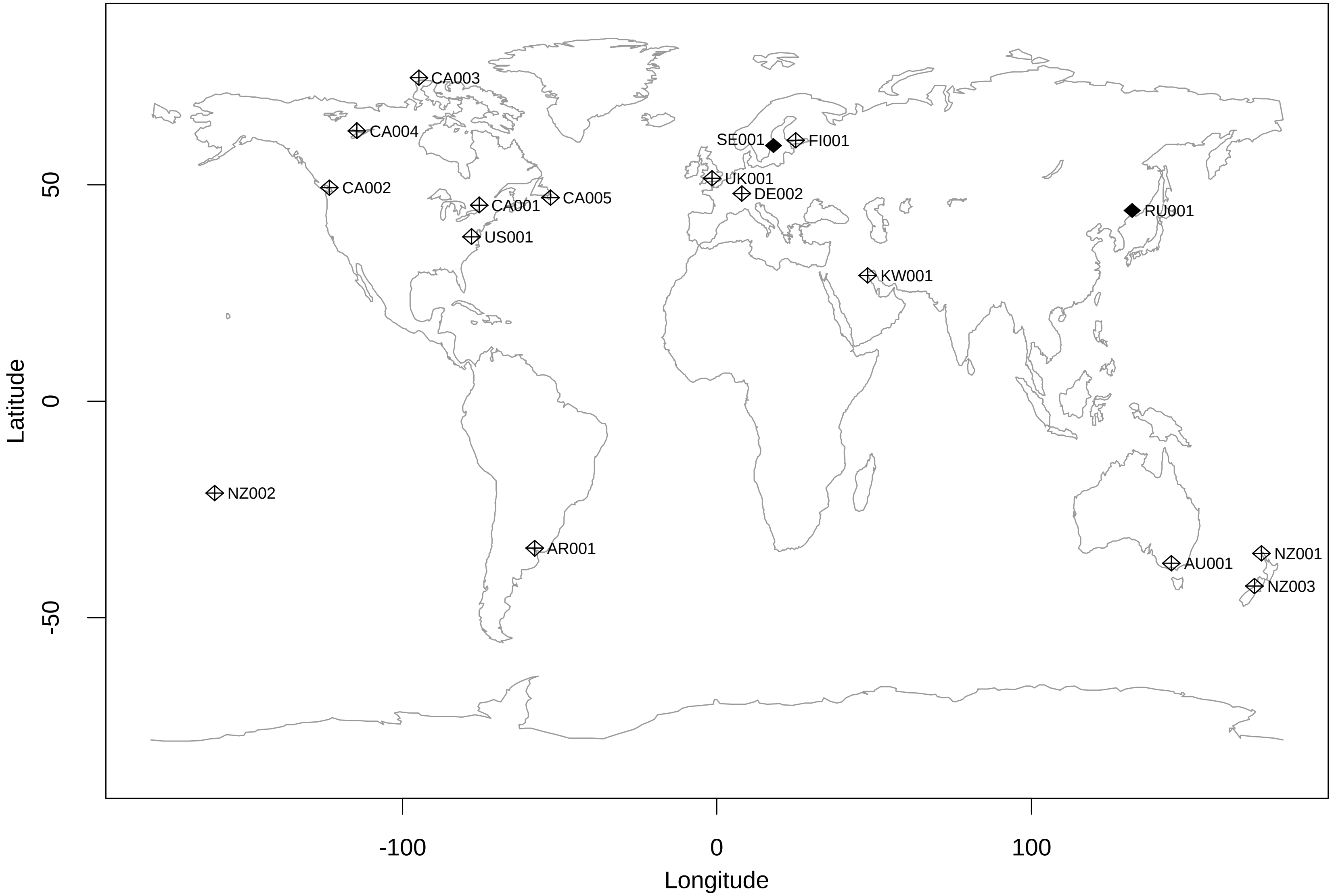


Figure 4. Radionuclide stations for which the IDC is currently receiving and reviewing data. The symbol indicates the type of data provided: open = gas, open with "+" = particulate; solid = both.

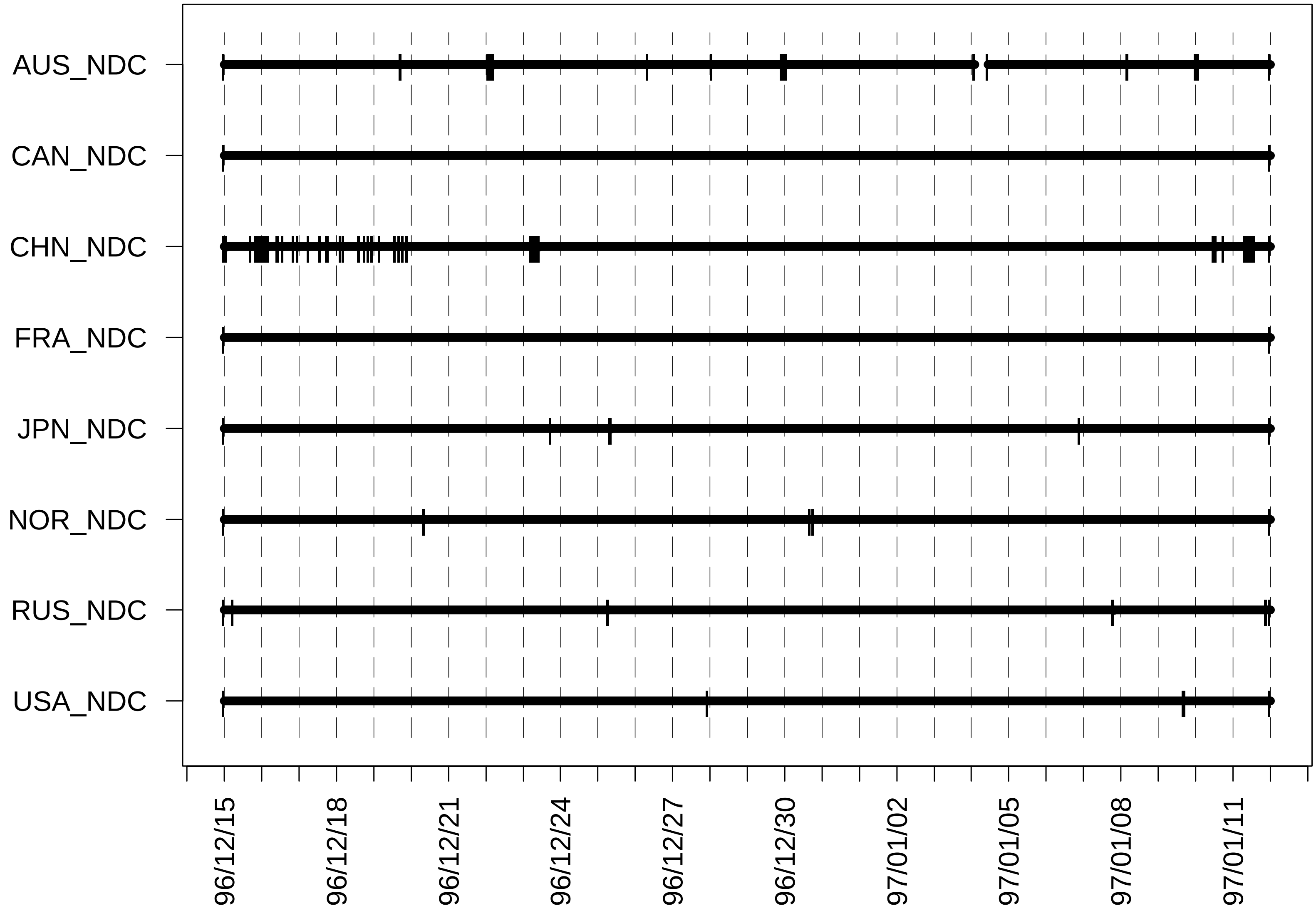
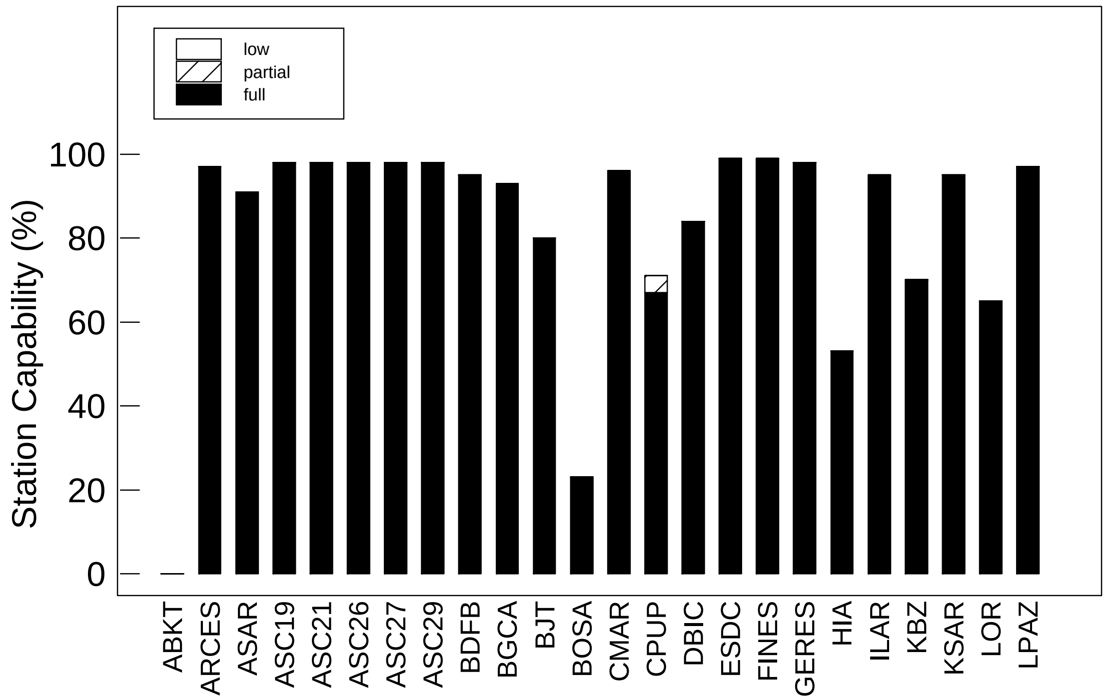


Figure 5. Connection histories of communication links from data centers to the International Data Center (IDC). Gaps in the time lines are bounded by tick marks and indicate breaks in communication.



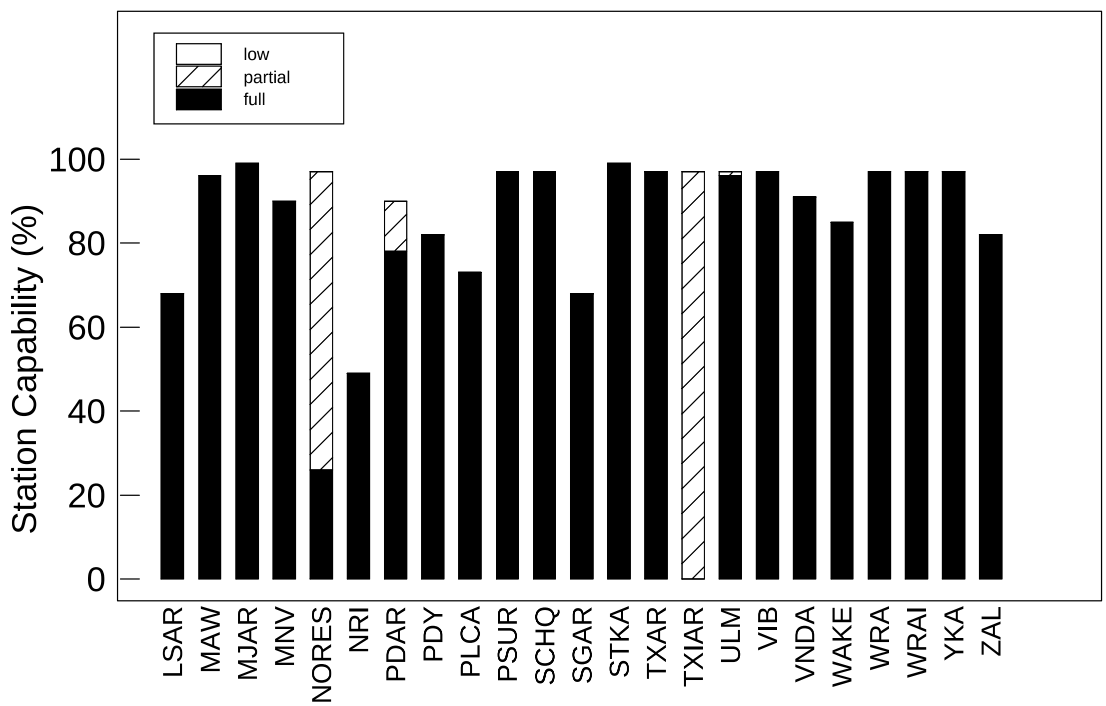


Figure 6. Capability of primary and acoustic stations as observed at the IDC. Capability categories are based on signal gain (SG), defined as the ratio of signal gain to the maximum theoretically possible for the station. Categories are: Full, SG >= 90%; Partial, 70% <= SG <= 90%; low, SG < 70%; Null, no data.

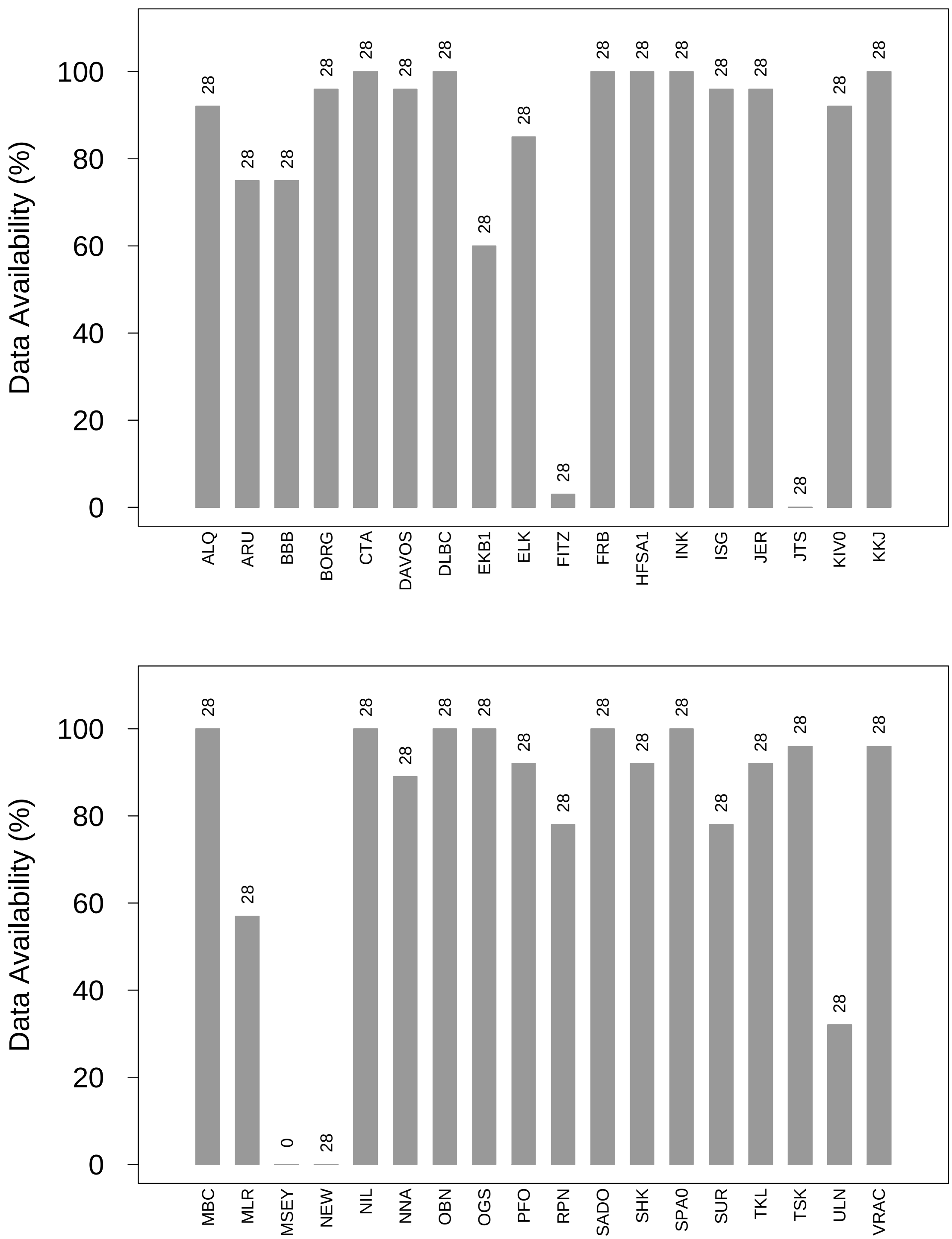


Figure 7. Availability of auxiliary seismic data. Bars indicate percentages of pollings for which data were successfully retrieved from stations (i.e., at least 95% retrieval). Each station is normally polled once a day. The number of completed polls is shown for each station. A single site is polled for each array station (EKB1 for EKA, HFSA1 for HFS, KIV0 for KVAR, SPA0 for SPITS). Telephone stations not shown.

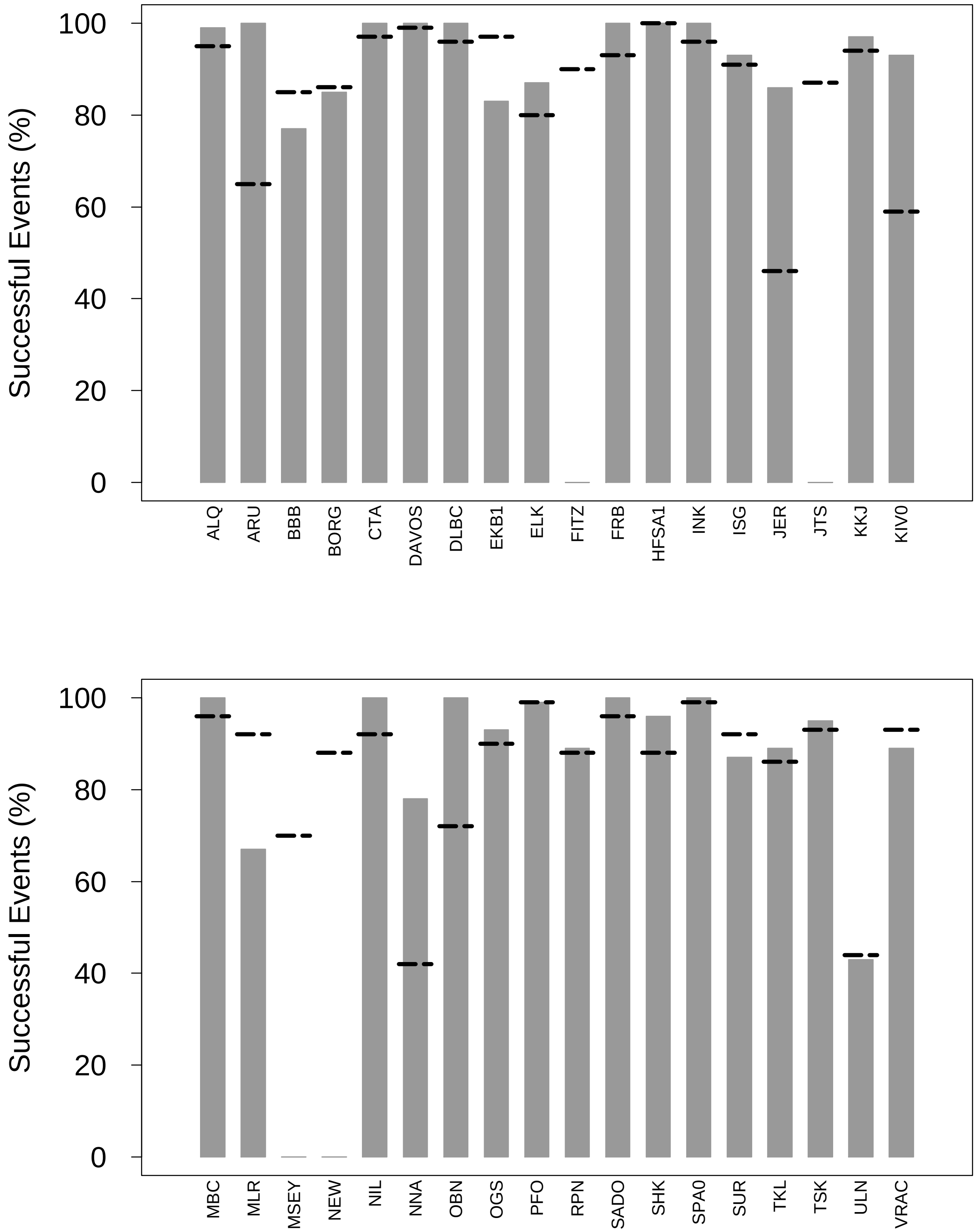


Figure 8. Percentage of times that requests for data from auxiliary stations were successful for distinct events in the AEL. Tick marks indicate percentages since January 1, 1996. Telephone stations are not shown.

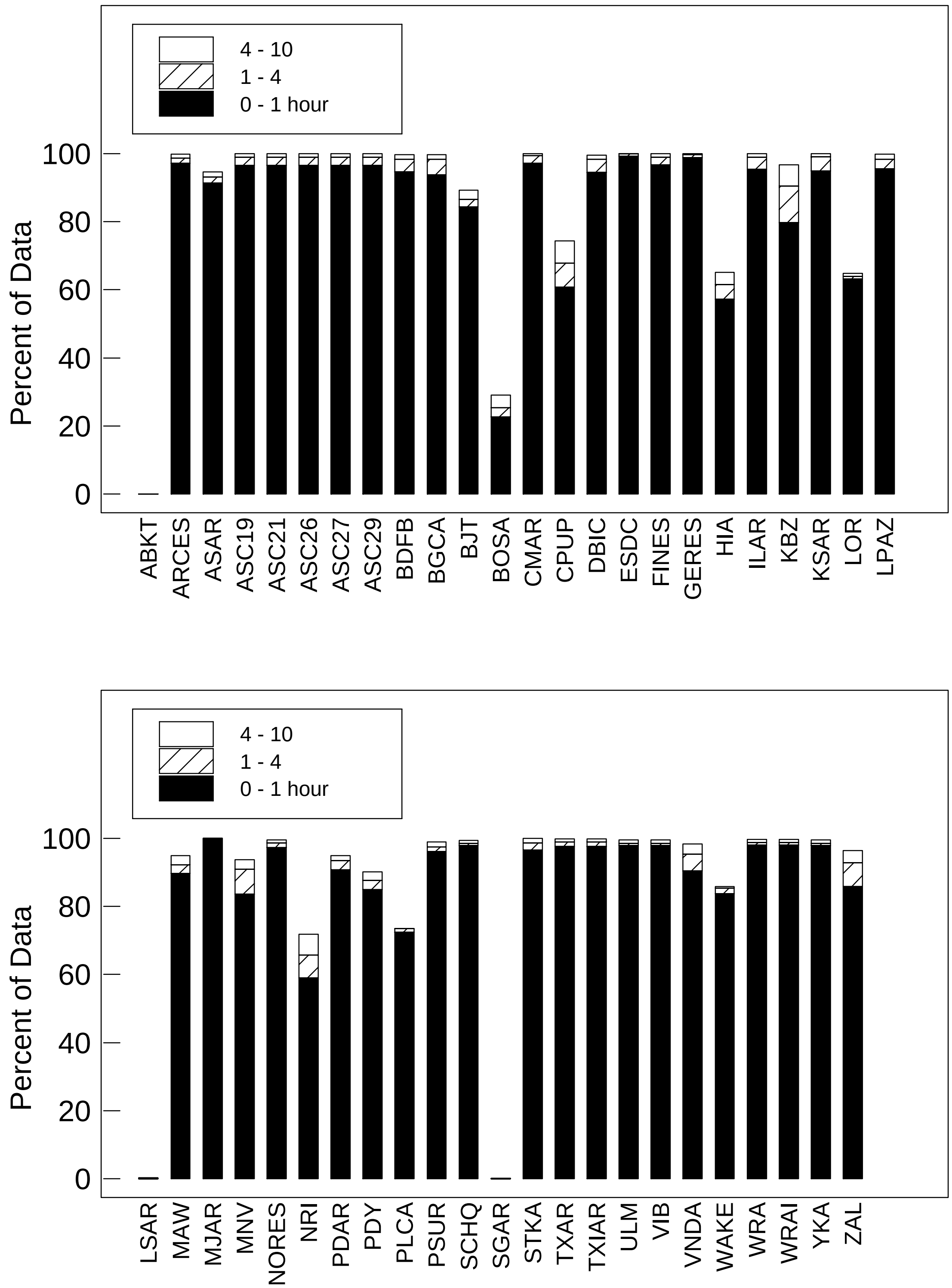


Figure 9. Time delay from event origin time to receipt at the IDC for primary and hydroacoustic data. Null space above bars indicates the percentage of data that took more than 10 hours to arrive.

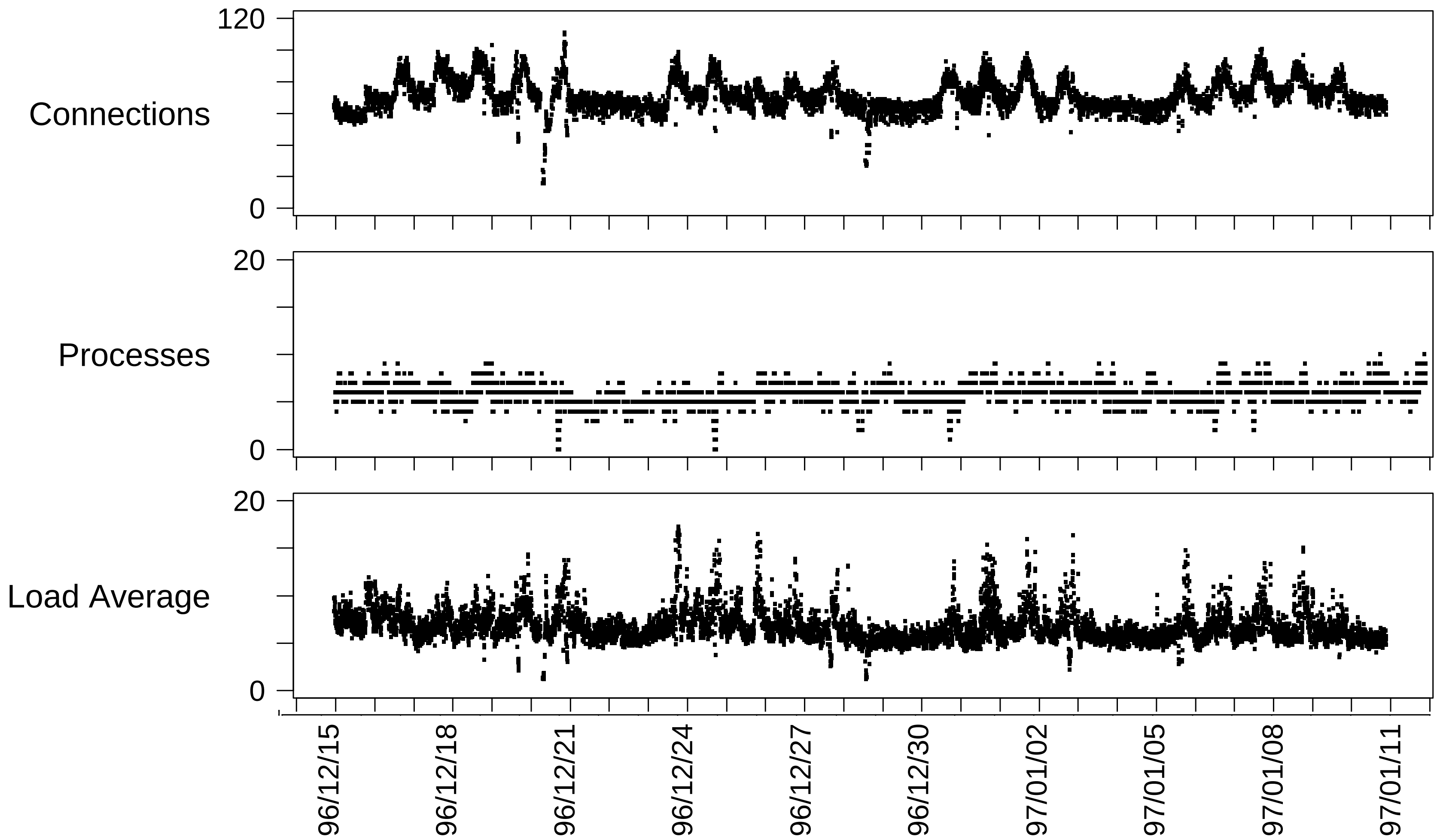


Figure 10. Performance of the operational database, alsvid, at 5-minute intervals. Connections show the number of processes connected to the Oracle database, which is licensed for 144 connections. Processes show the number of processes running on the operational Oracle instance; at any given time, the majority of connects are idle. The load average is the load averaged over 5 minutes on the eight-processor SPARCcenter 1000 used as the operational database server.

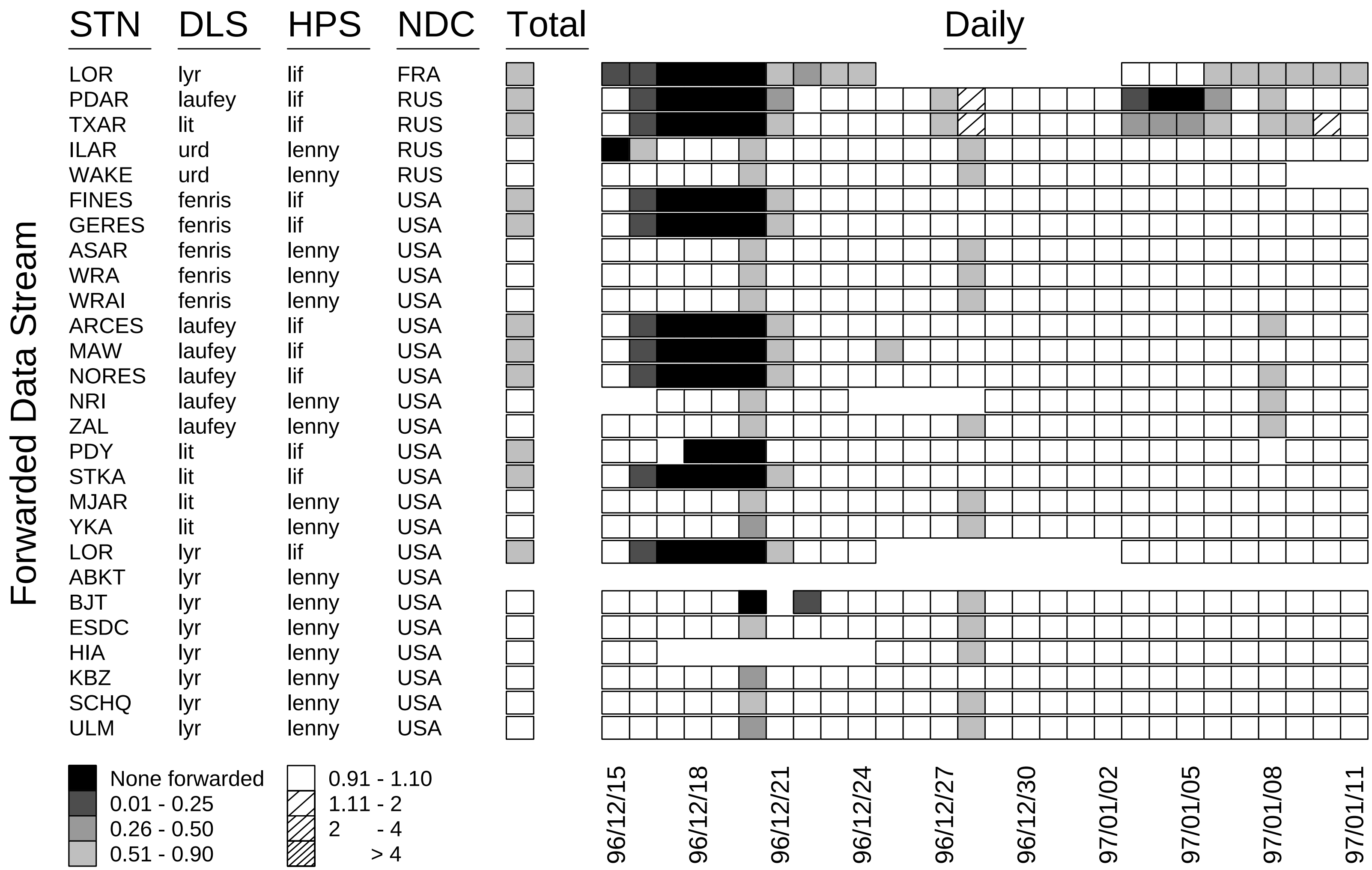


Figure 11. Progress of continuous waveform forwarding from the IDC to subscribing NDC’s. Data streams are grouped by NDC, followed by diskloop server (DLS), which receives the data at the IDC, and heap server (HPS), which forwards it. Absence of bricks indicates that the data were not received at the IDC. Data streams discontinued during or subsequent to the period may not be shown.

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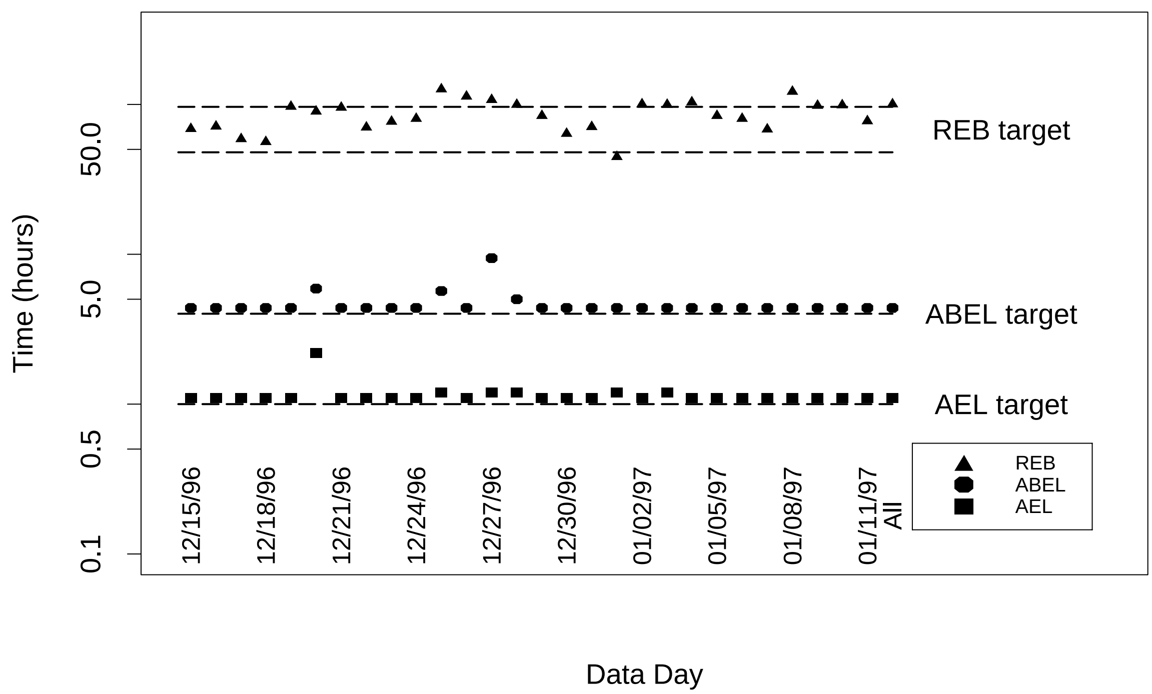
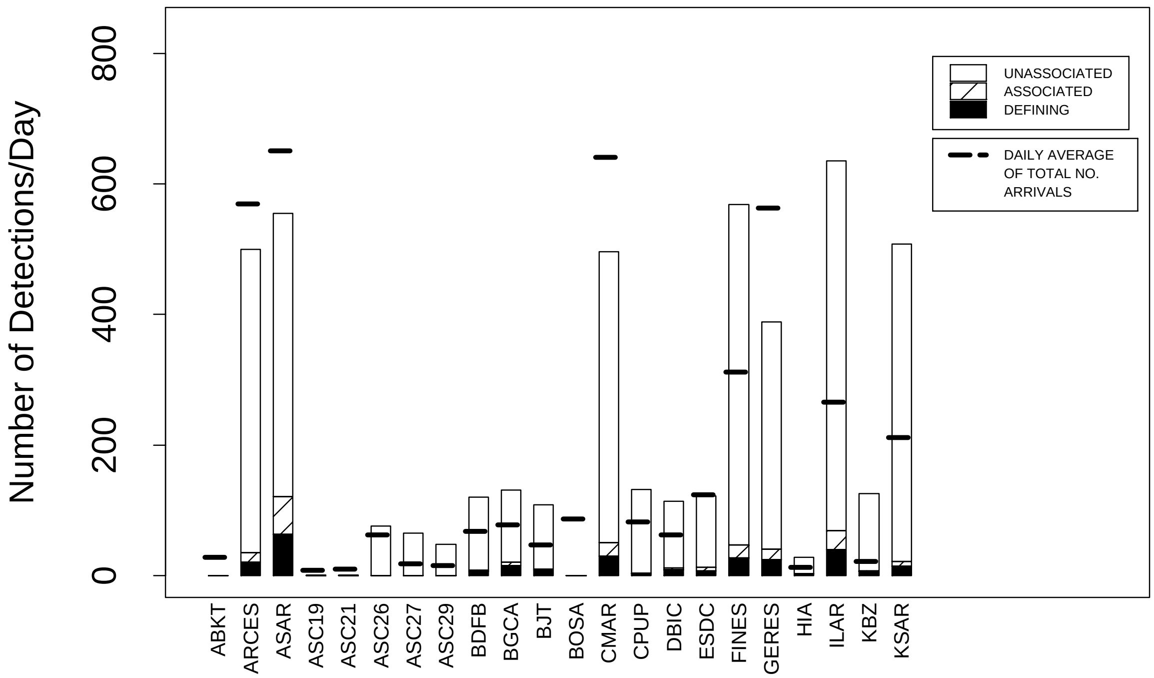


Figure 12. Time of entry of 90% of the events into the database for the AEL, ABEL, and REB for this period. Target times for completion of automatic bulletins are 1 hour (AEL), and 4 hours (ABEL) after each event's origin time. The target time for the REB is 2 to 4 days after the end of the data day, which is 48 to 96 hours after event origin times.



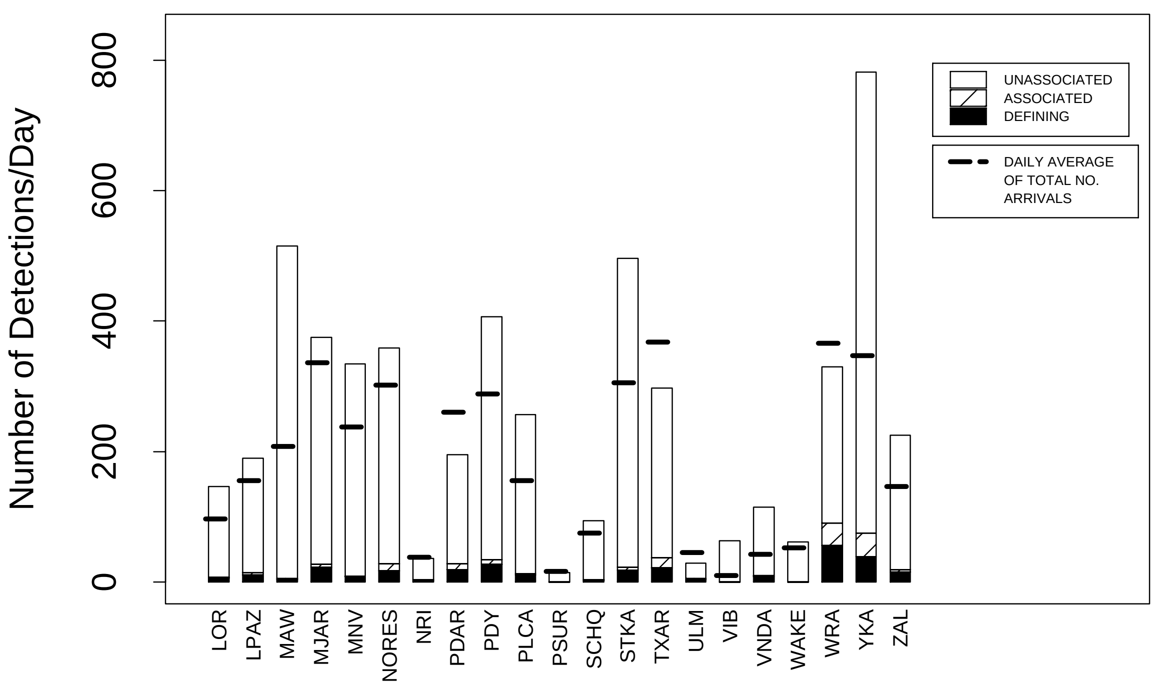
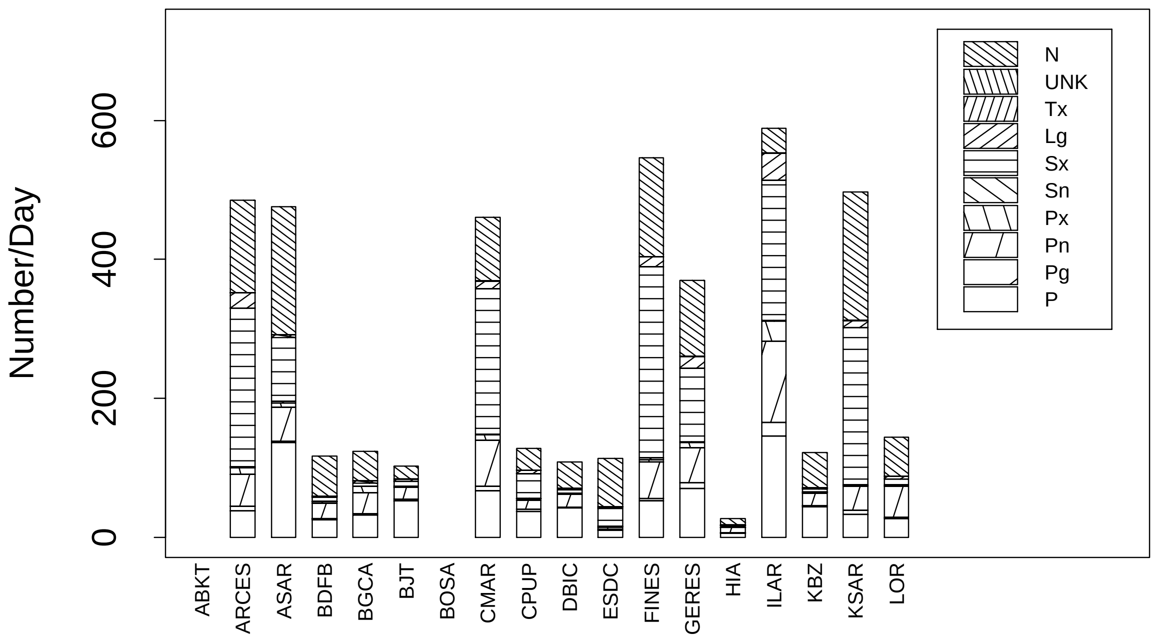


Figure 13. Numbers of automatic detections per day for primary and hydroacoustic stations. Detections are from the DEL where each detection is either a defining phase, an associated but non-defining phase or an unassociated phase. Dashed lines show averages previous to this period since January 1, 1996.



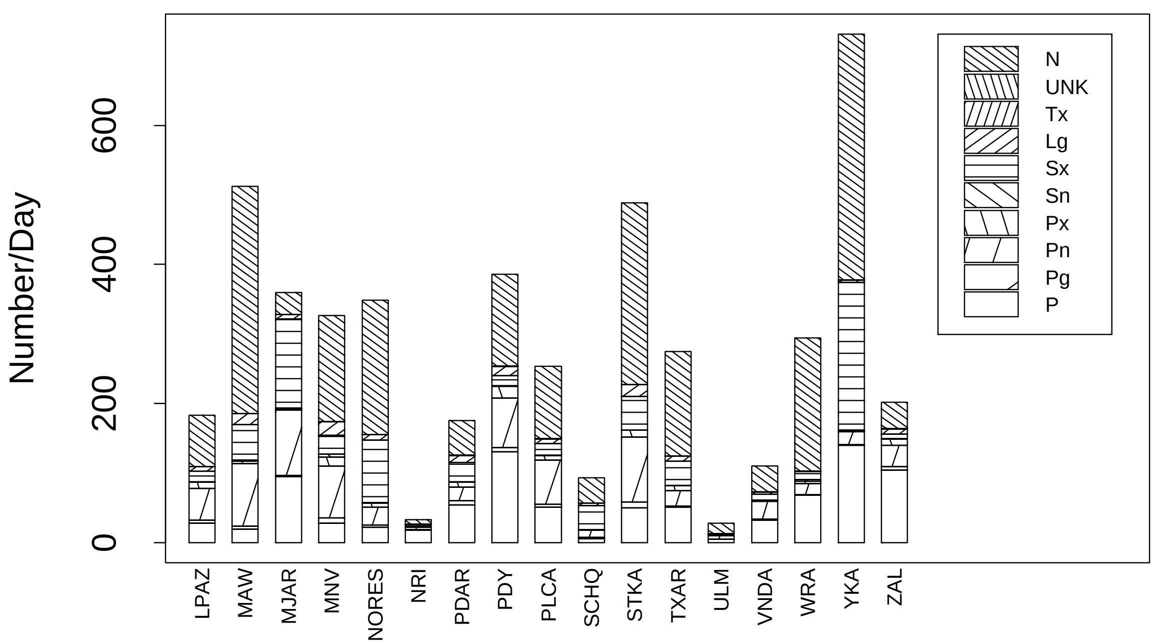
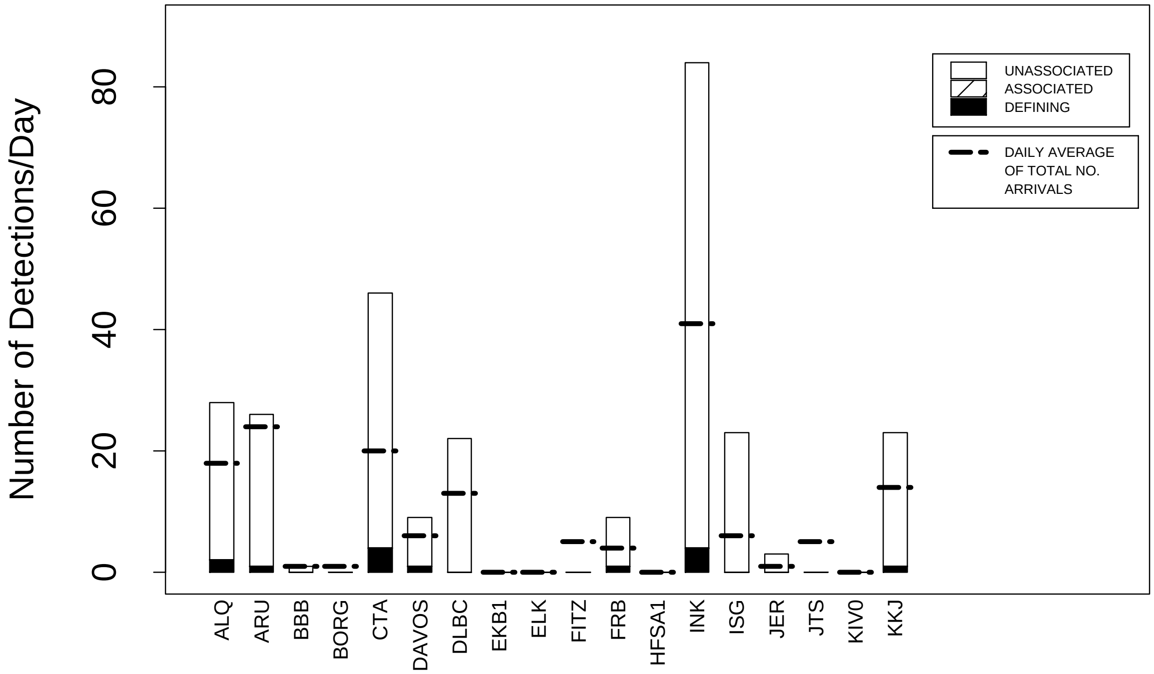


Figure 14. Numbers of arrivals per day that were unassociated for primary stations. Phase identifications are from the DEL.



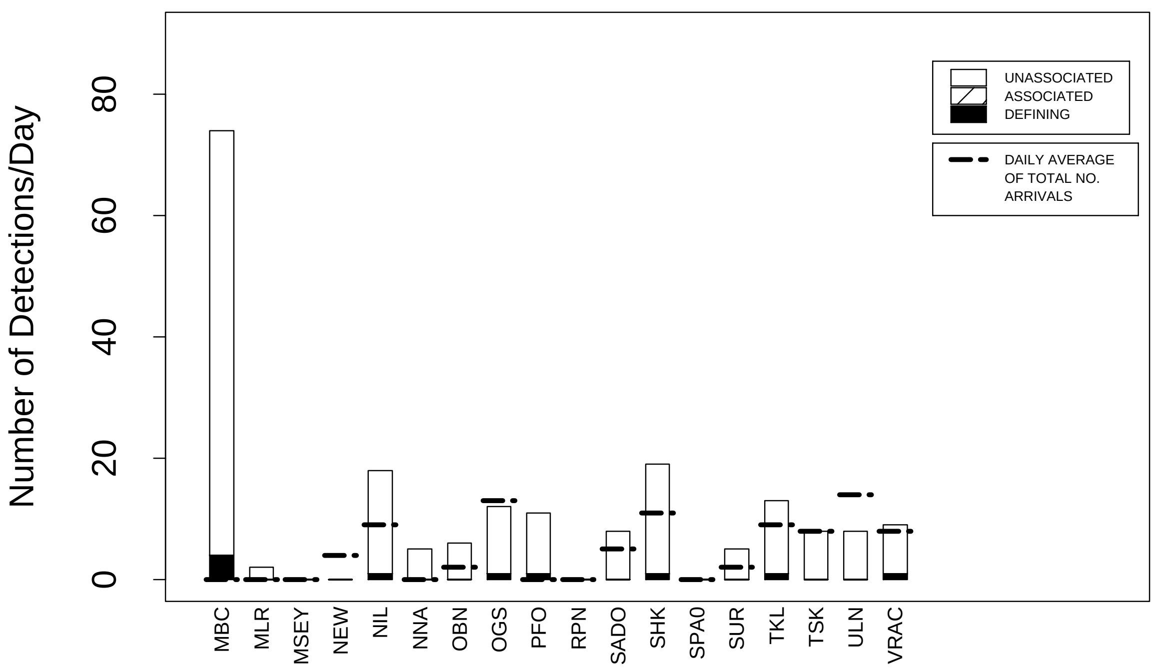


Figure 15. Number of automatic detections per day for each auxiliary station. Detections are from the DEL where each detection is either a defining phase, an associated but non-defining phase or an unassociated phase. Dashed lines show averages previous to this period since January 1, 1996. Telephone stations are not shown.

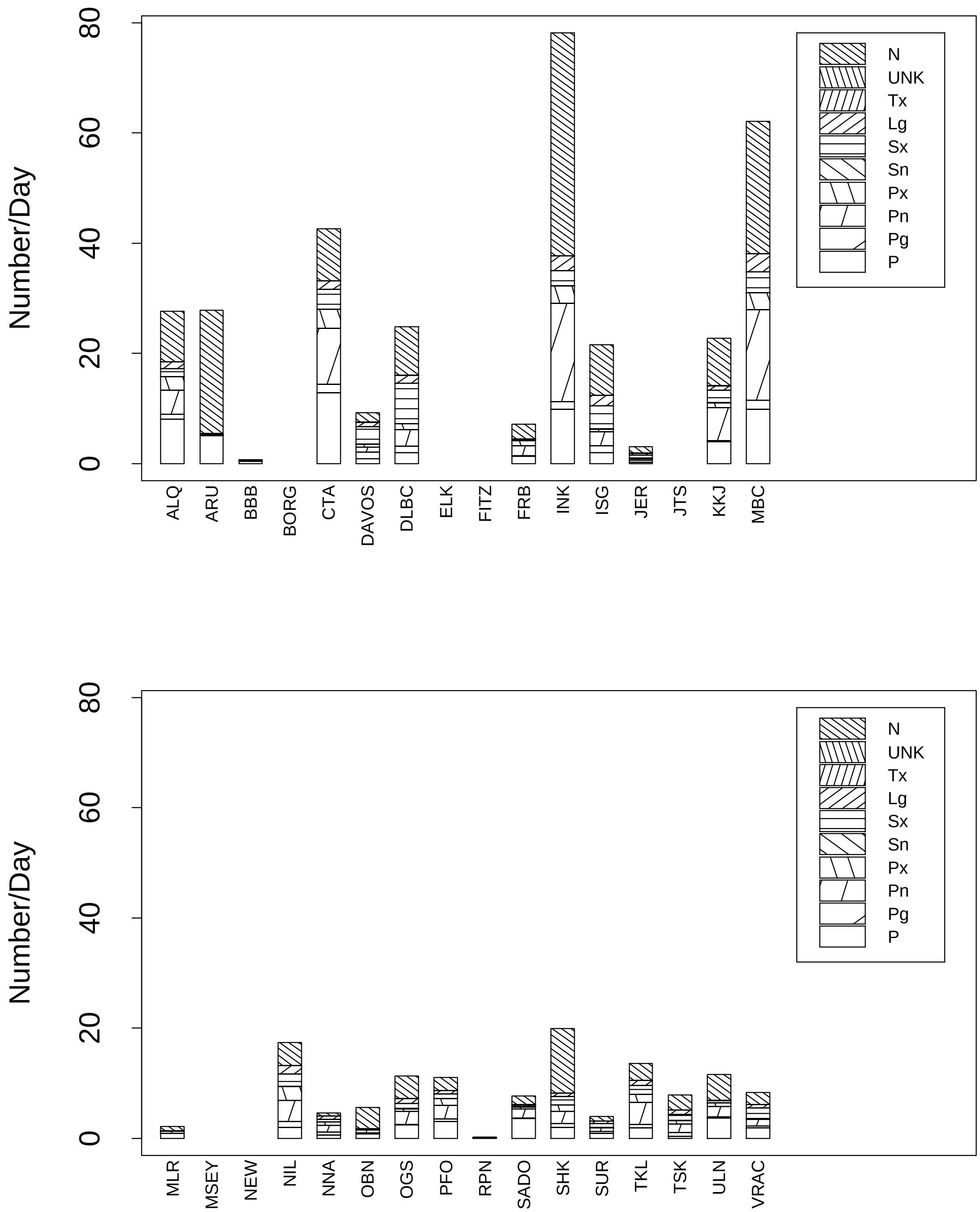
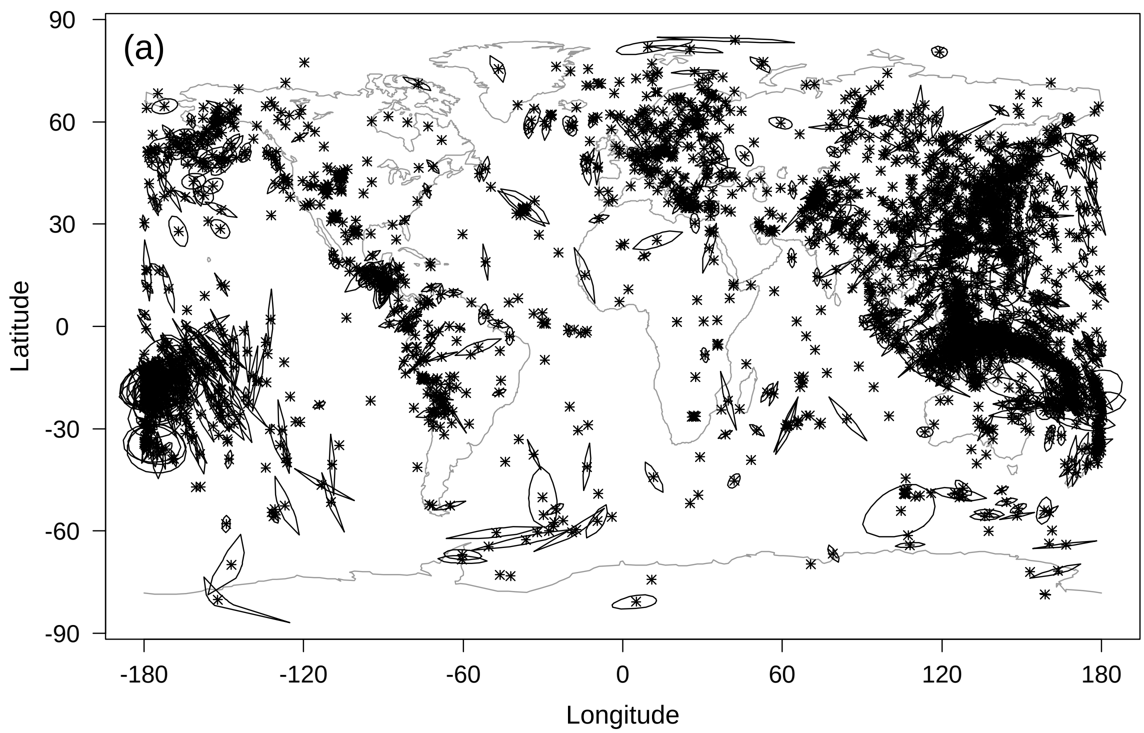


Figure 16. Number of arrivals per day that were unassociated for each auxiliary station. Phase identifications are from the DEL. Telephone stations are not shown.



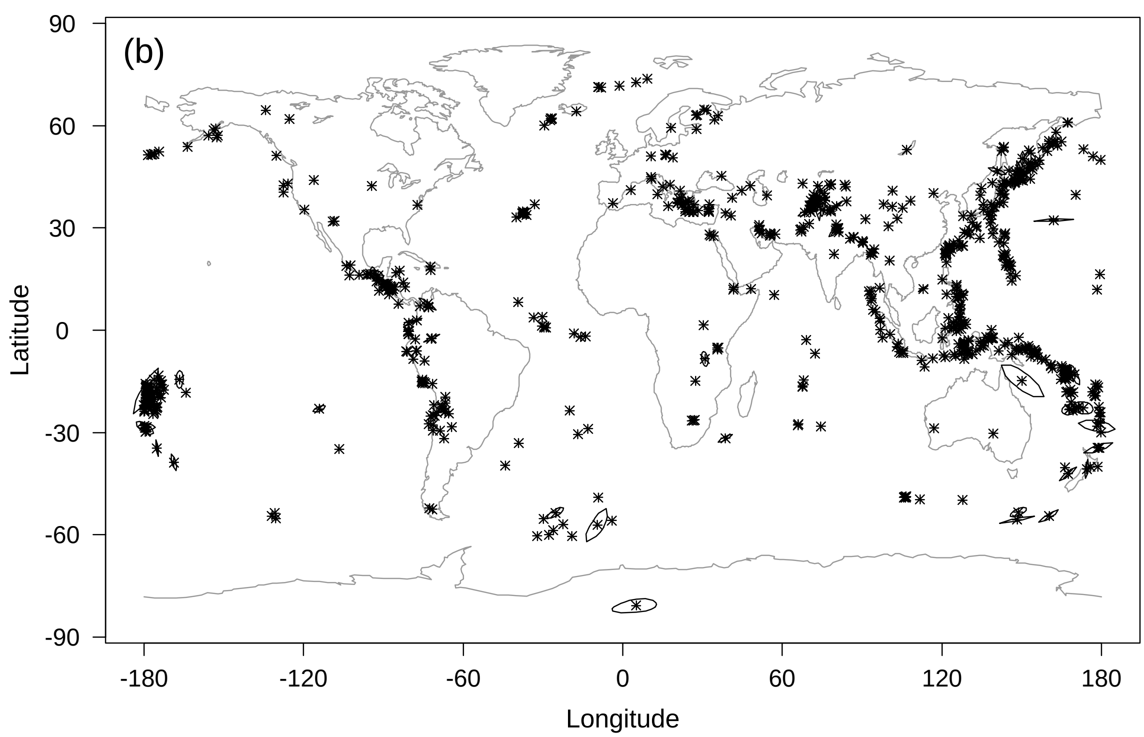


Figure 17. (a) All DEL events in the world for the period of this report. (b) Events from (a) with at least 6 defining phases. Ellipses are 90% confidence limits and, in (b), are usually smaller than the asterisk.

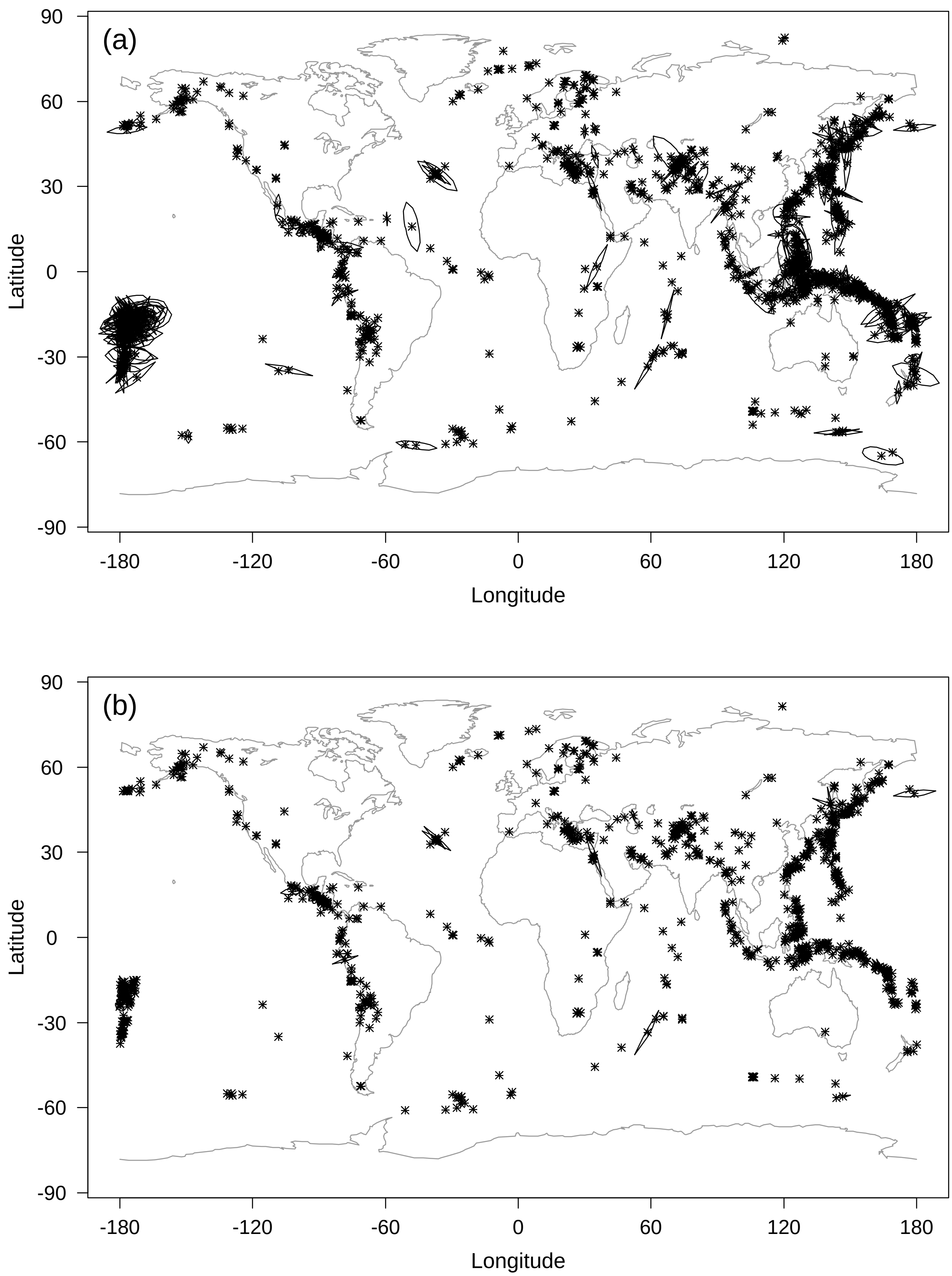


Figure 18. (a) All REB events in the world for the period of this report. (b) Events from (a) with at least 6 defining phases. Ellipses are 90% confidence limits and, in (b), are usually smaller than the asterisk.

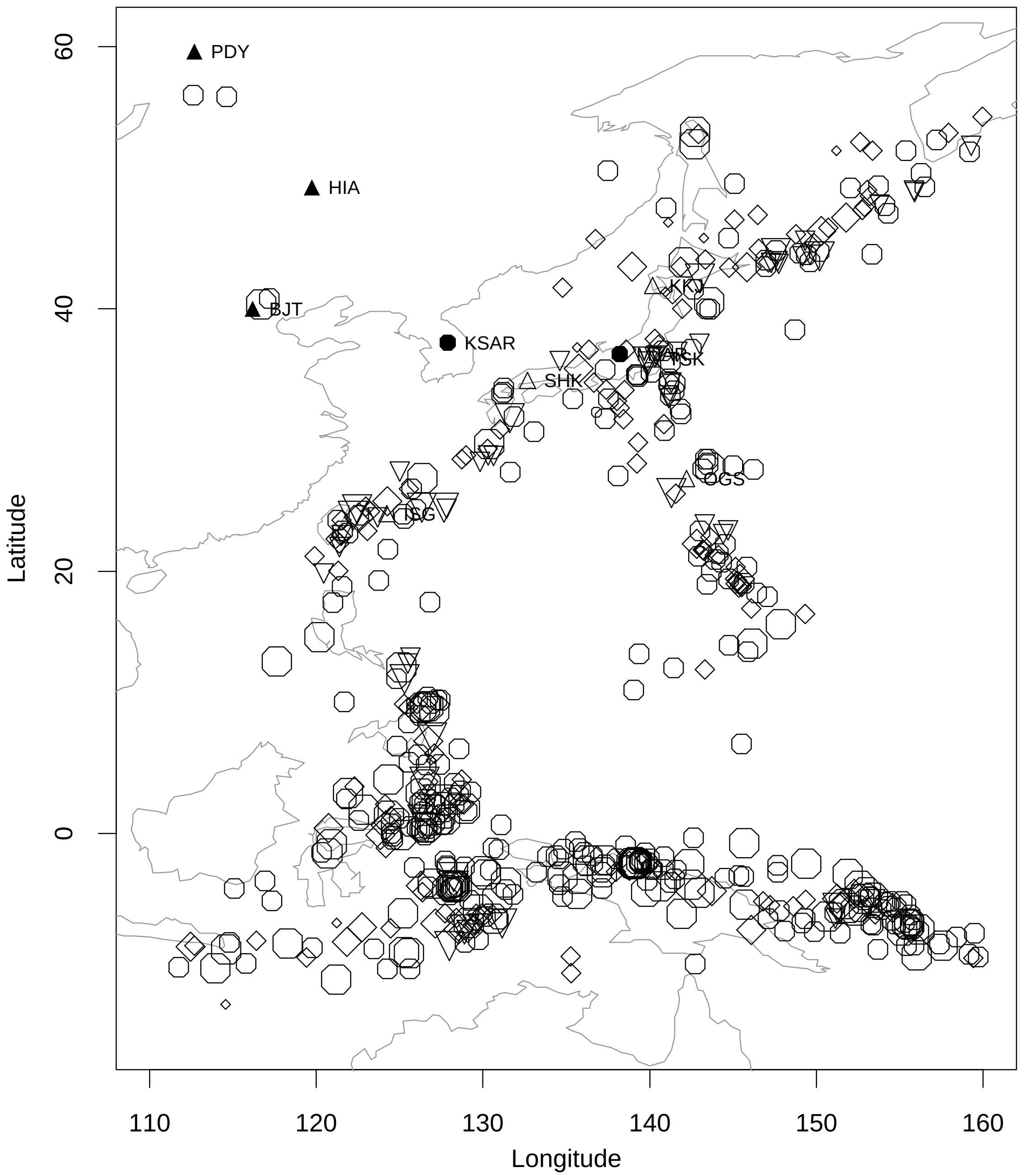


Figure 19. REB events in the western Pacific showing the depth and body-wave magnitude ranges. Error ellipses were left out for clarity. Primary and auxiliary stations are marked with filled and unfilled symbols respectively. Array stations and 3-C stations are marked as circles and triangles respectively.

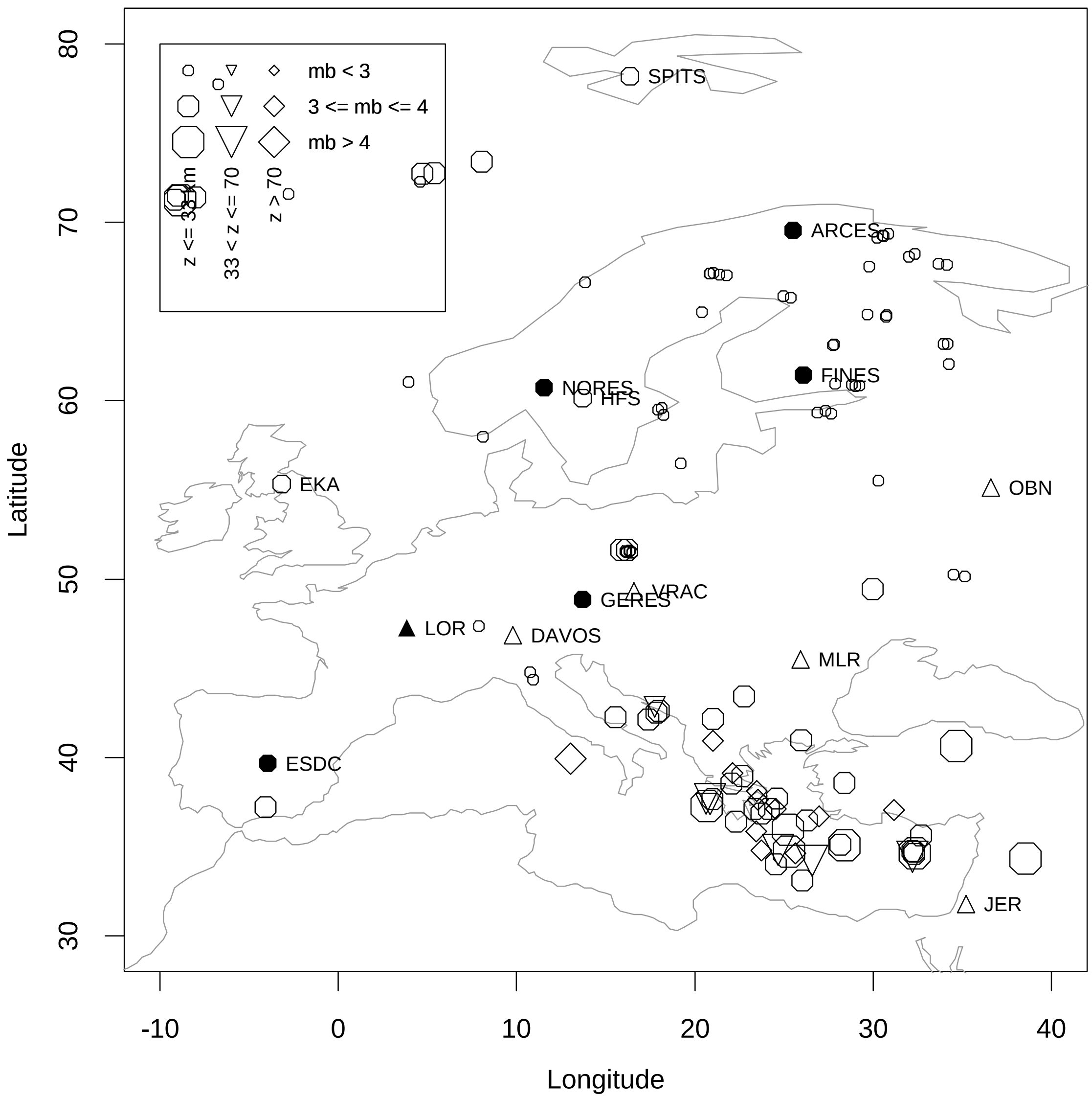


Figure 20. REB events in Europe showing the depth and body-wave magnitude ranges.

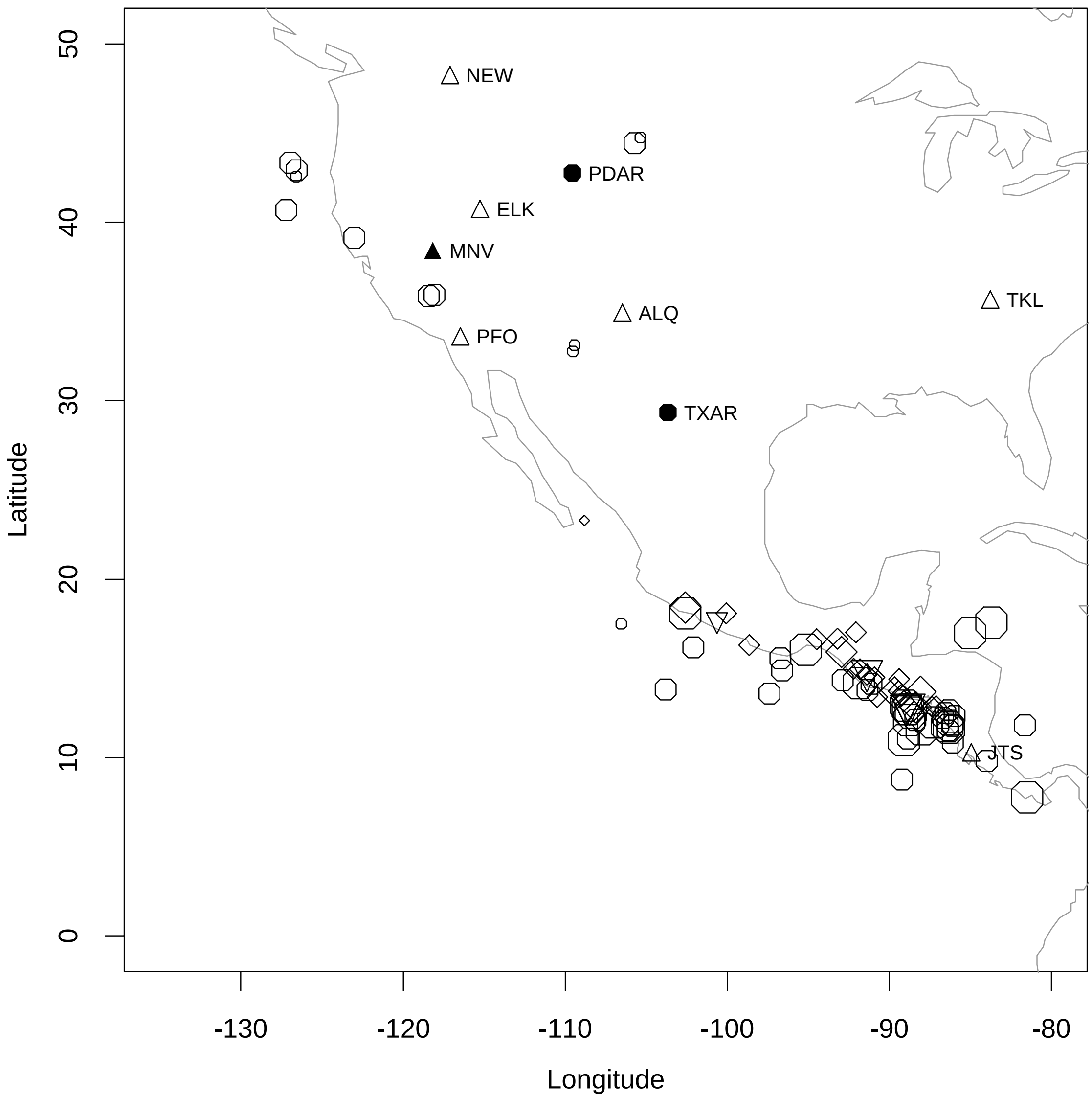


Figure 21. REB events in the western United States and central America showing the depth and body-wave magnitude ranges.

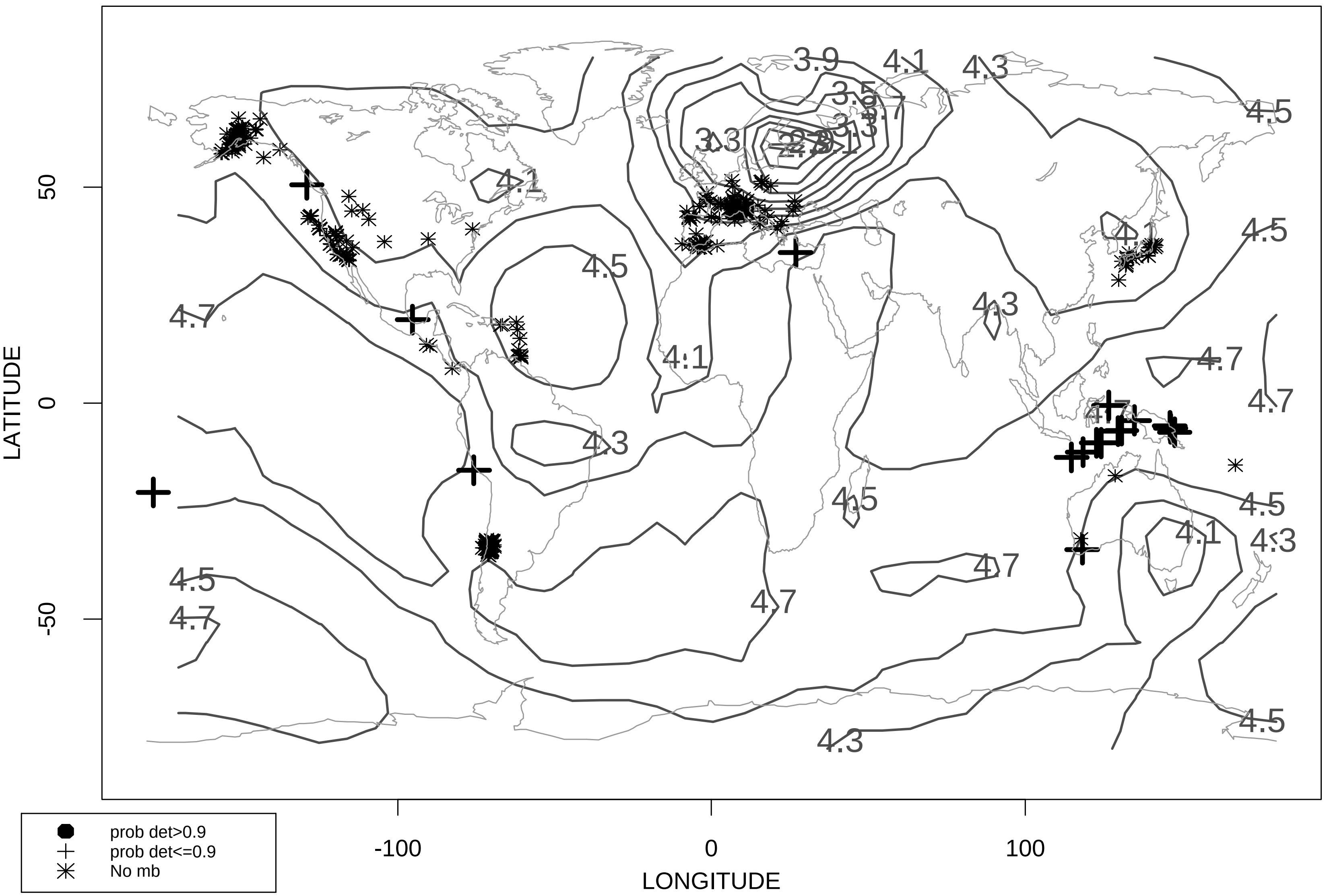


Figure 22. Events reported in the Quick Epicenter Determination (QED) but not the REB for the period October 20 through November 16, 1996. Contours show estimated detection capability at 90% probability for the primary network with three P detections. Solid circles, if any, are events in the QED that were not in the REB and had a probability of detection by the primary network > 90%. Plus signs show events in the QED that are not in REB but had 90% or less detection probability. Asterisks are events in the QED for which no m_b was reported and no estimate of detection probability can be made.

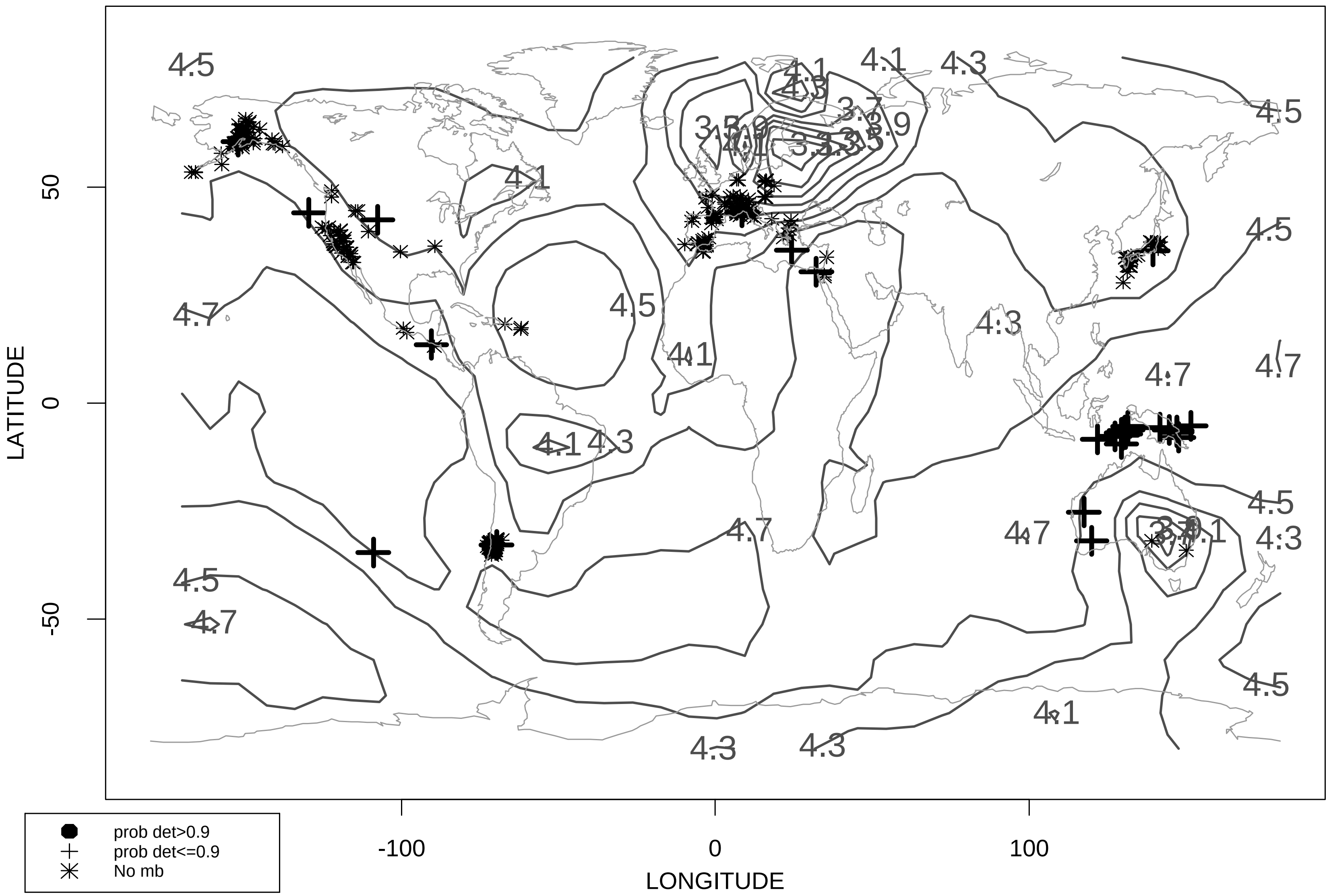


Figure 23. Events reported in the Quick Epicenter Determination (QED) but not the REB for the last period. Contours show estimated detection capability at 90% probability for the primary network with three P detections. Solid circles, if any, are events in the QED that were not in the REB and had a probability of detection by the primary network > 90%. Plus signs show events in the QED that are not in REB but had 90% or less detection probability. Asterisks are events in the QED for which no m_b was reported and no estimate of detection probability can be made.

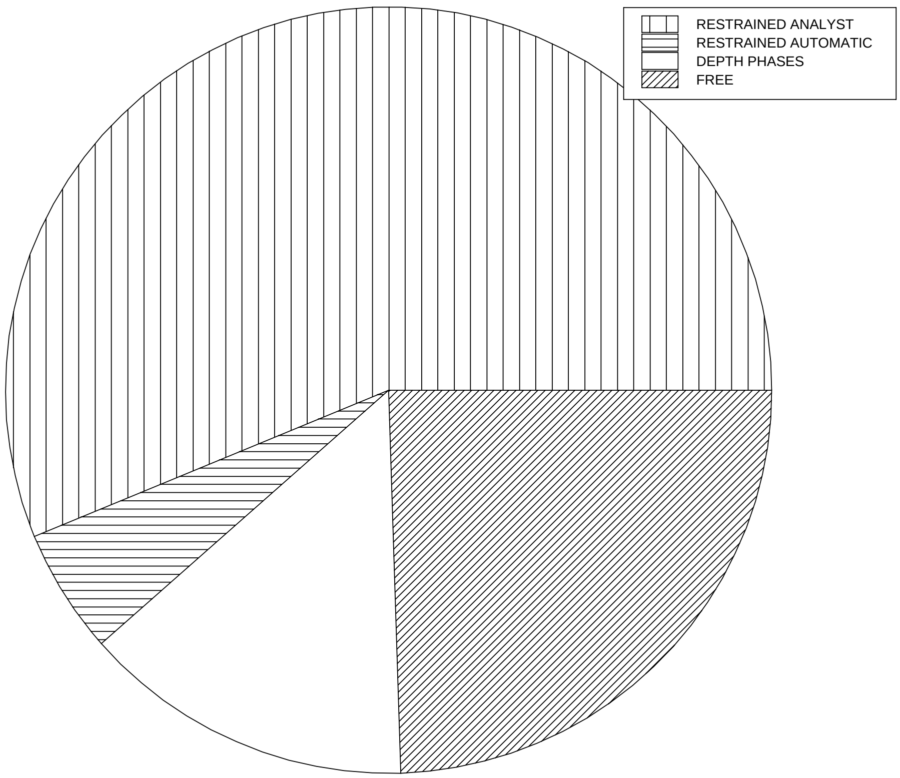


Figure 24. Depth constraints for events in the REB for the current period.

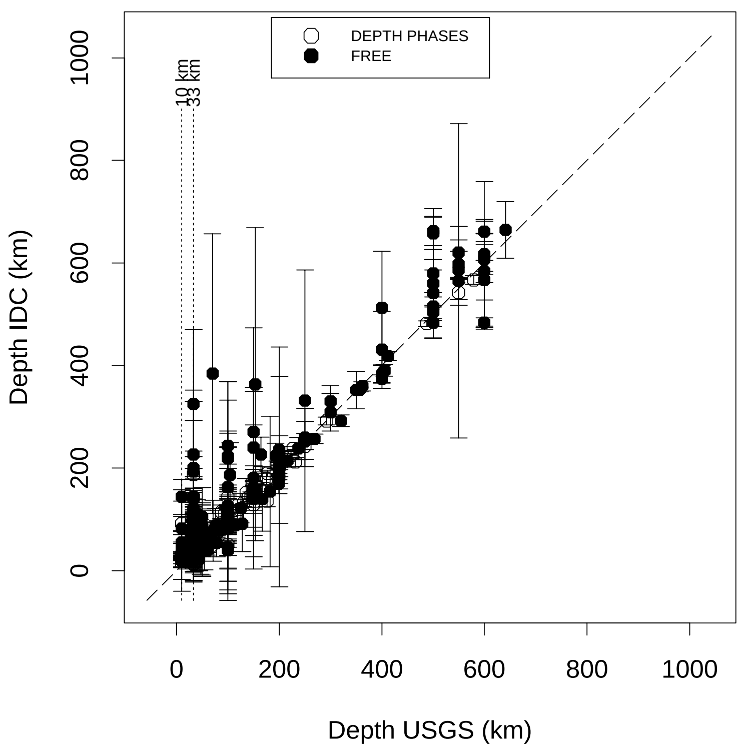


Figure 25. Comparison of unconstrained depths in the REB with those reported in the QED for common events. Symbol definitions refer to the REB values.

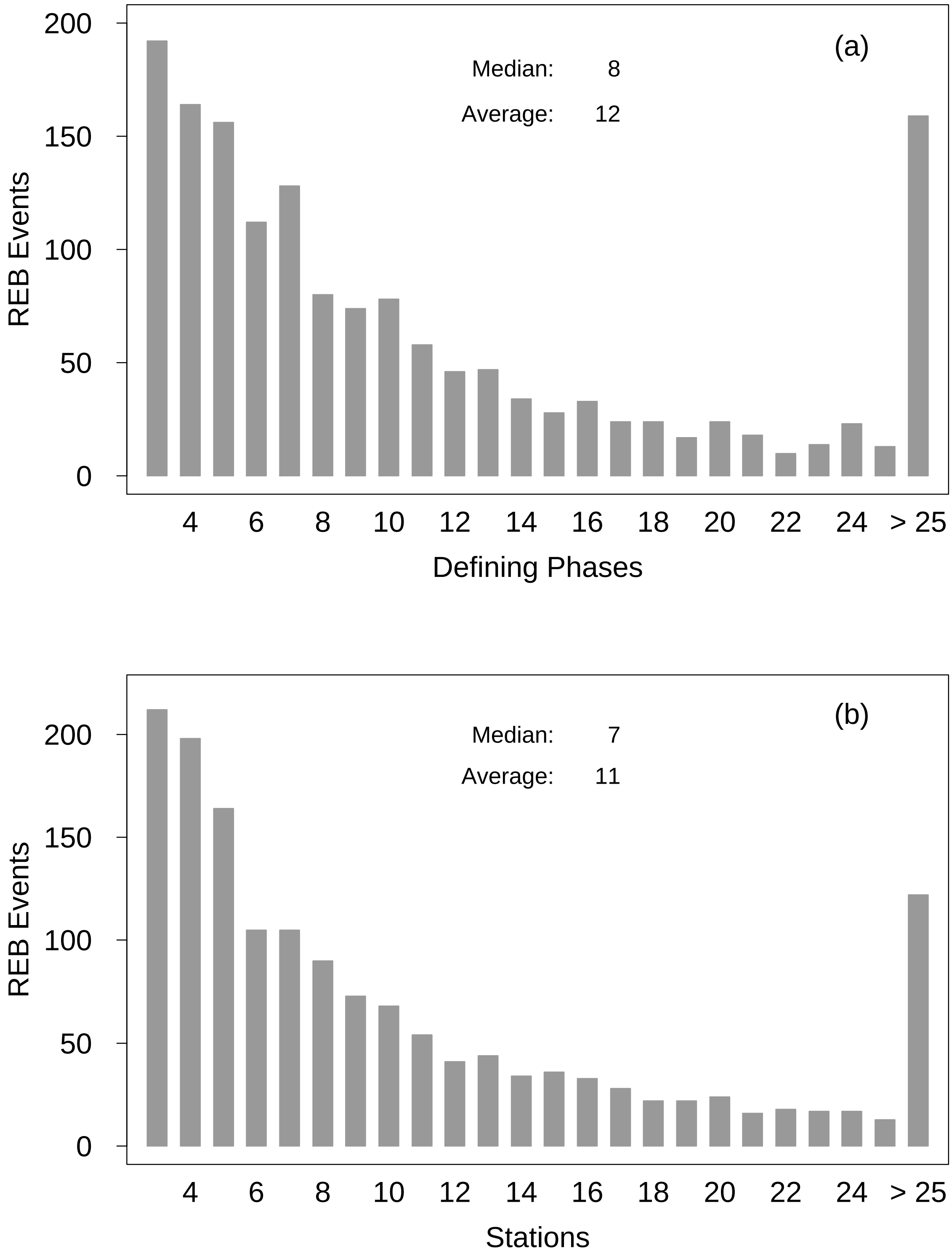


Figure 26. Numbers of events in the REB versus numbers of (a) defining phases and (b) primary and auxiliary stations.

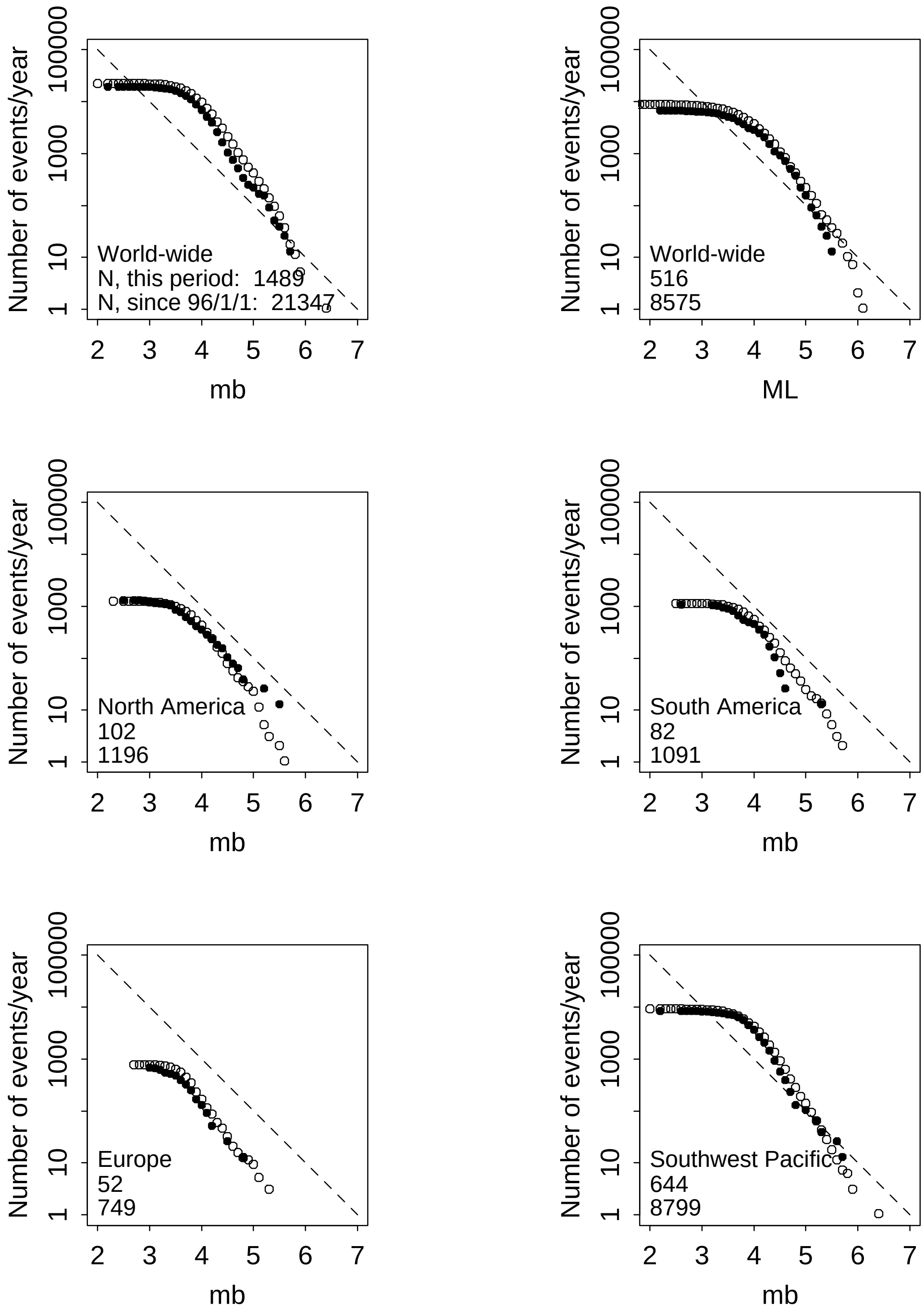


Figure 27. Recurrence distributions of body-wave (m_b) and local (ML) magnitudes in the REB for selected regions. Solid dots are for the current period, and open dots are for the previous time since 96/1/1. Posted numbers include all magnitudes > 0. The dashed lines have one-to-one slopes. Regions are defined as: North America 10^o N - 90^o N, 165^o W - 50^o W; South America 80^o S - 10^o N, 90^o W - 30^o W; Europe 30^o N - 80^o N, 15^o W - 30^o E; Southwest Pacific 80^o S - 0^o, 60^o E - 150^o W.

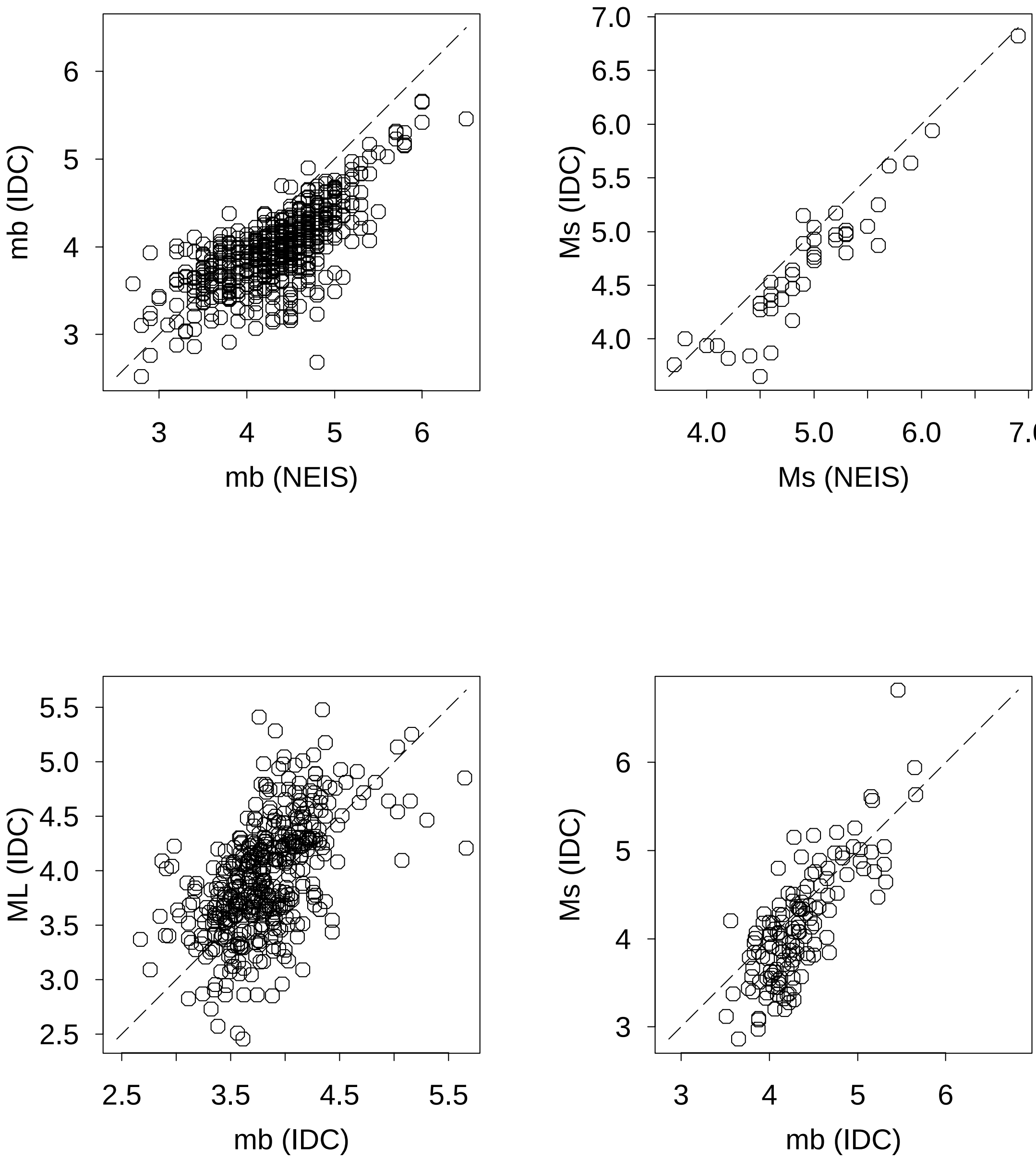


Figure 28. Comparisons of magnitudes from the REB with those for the same events in the QED (top) and REB comparisons of m_b with ML and Ms (bottom).

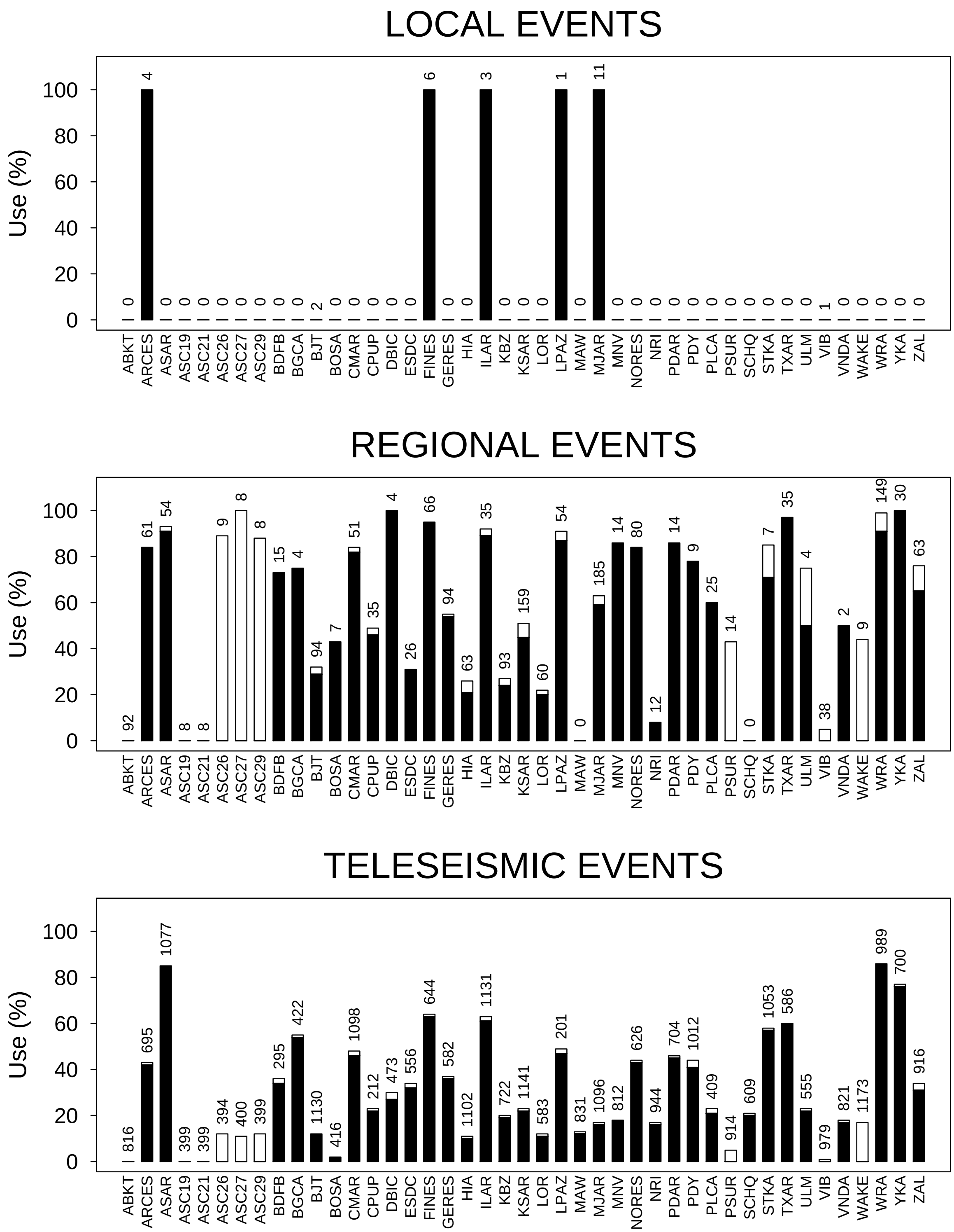


Figure 29. Use of primary and hydroacoustic stations in the REB for events at local $(0-2^o)$, regional $(2-20^o)$, and teleseismic $(20-90^o)$ distances. The number above each bar represents the number of events within the specified distance range of the station, and the height of the bar is the percent of that number for which the station was associated in a defining (filled) or non-defining (unfilled) sense in the REB solutions. Unfilled bars are stacked above filled bars.

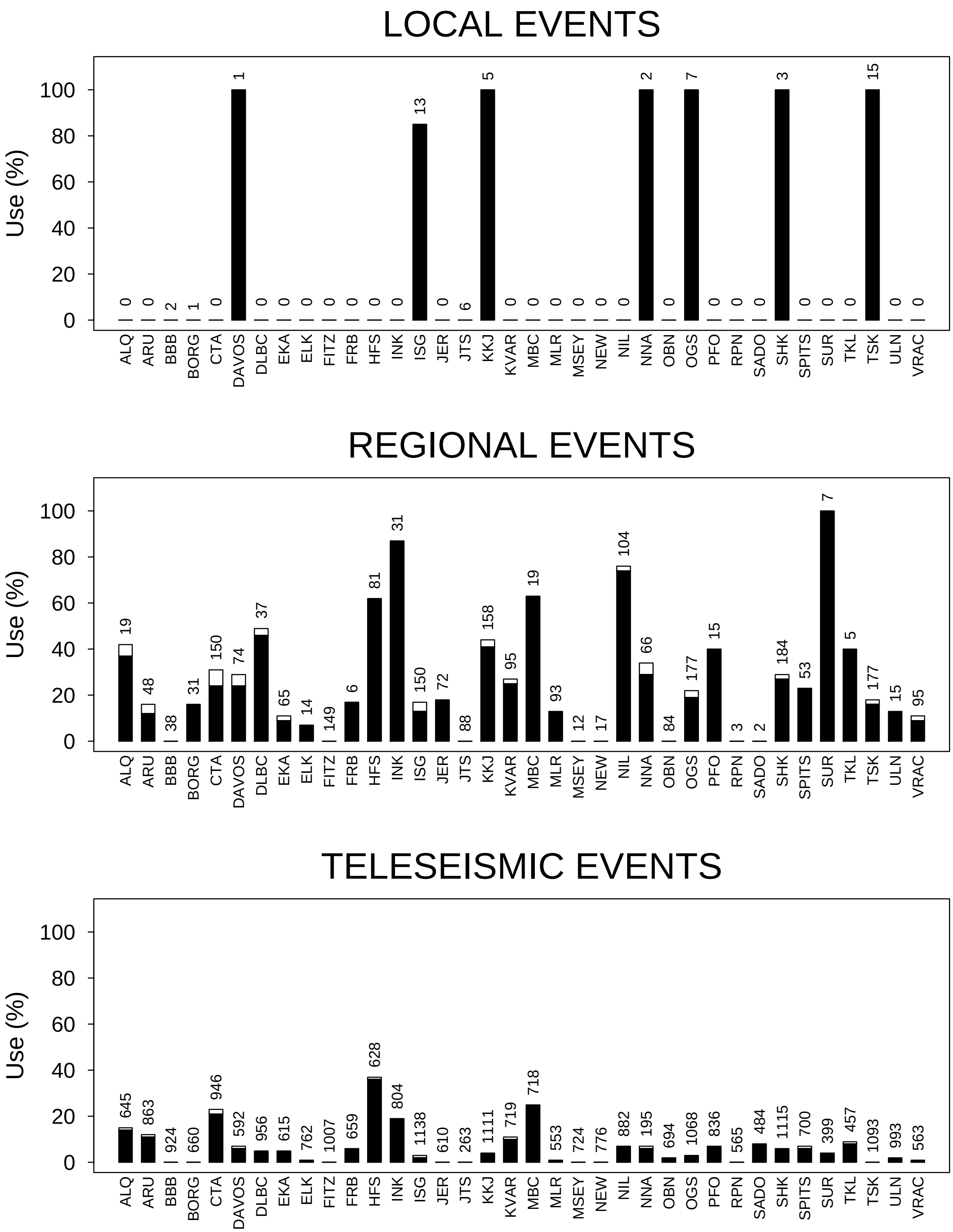


Figure 30. Use of auxiliary stations in the REB for events at various distance ranges. Telephone stations are not shown.

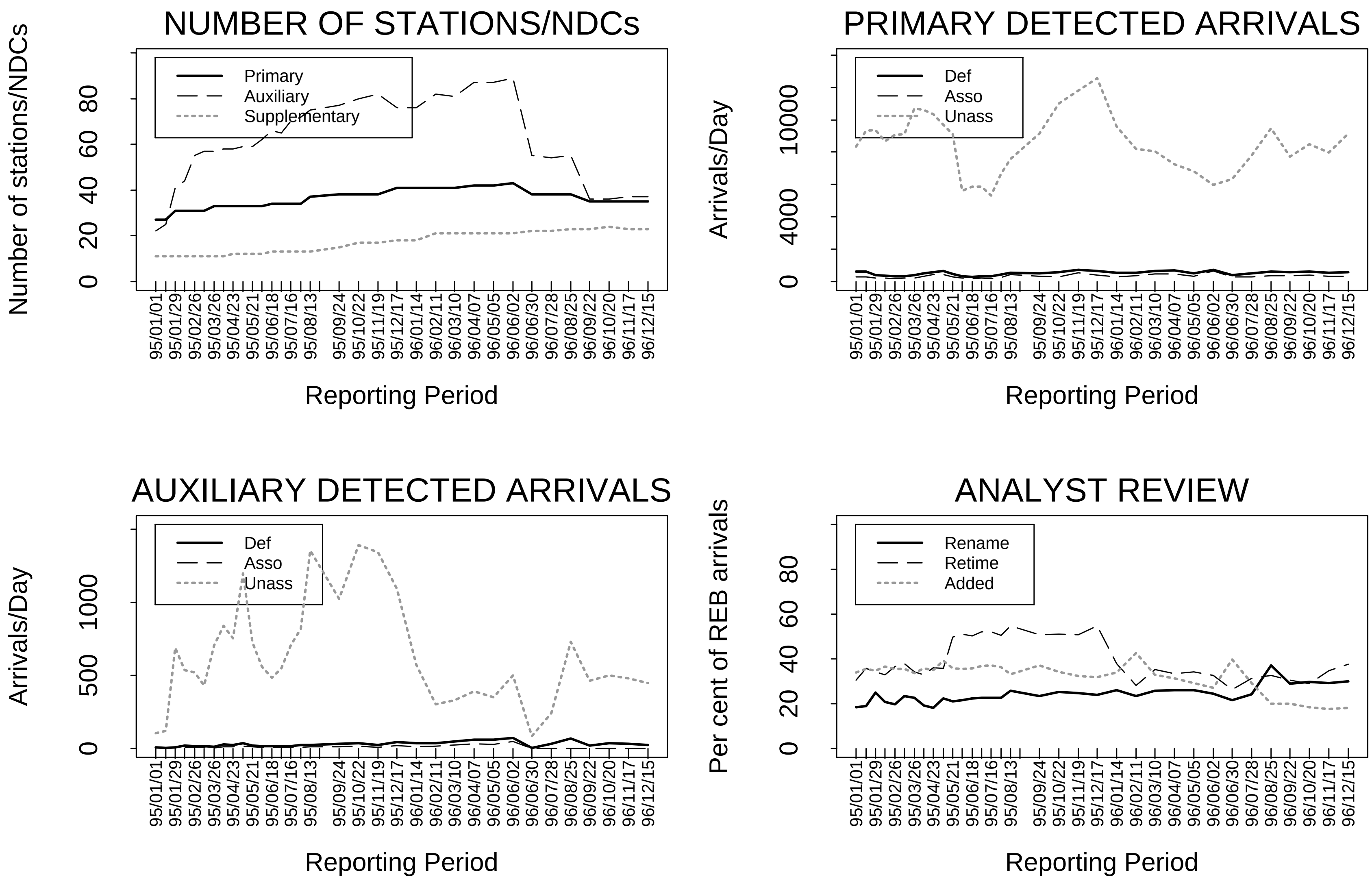


Figure 31. Performance of network and signal processing since the beginning of GSETT-3, Version 3. Dates shown are the beginnings of the report periods represented by the data points. Phase detections are from the DEL.

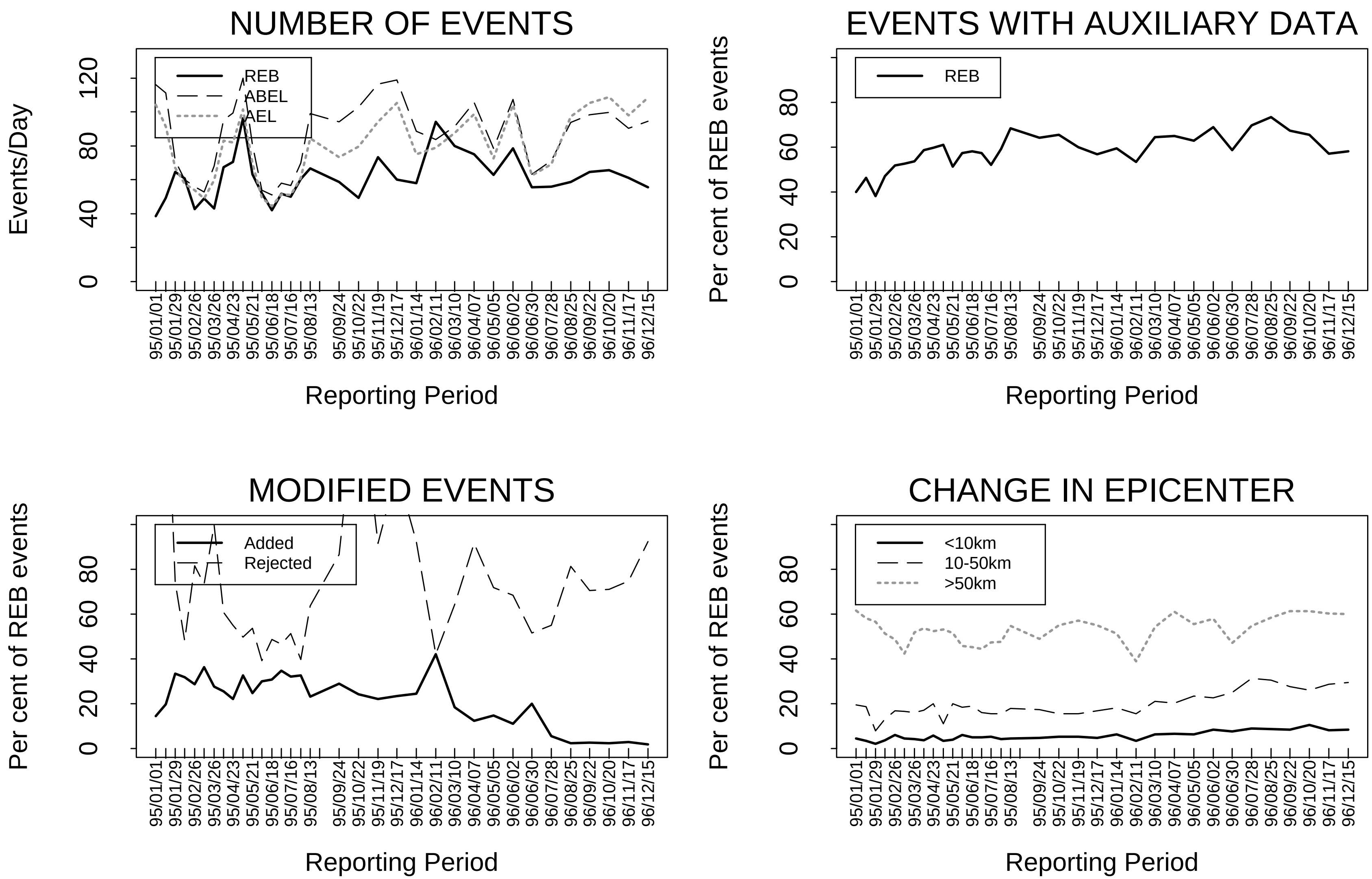


Figure 32. Performance of event processing, since the beginning of GSETT-3, Version 3. Dates shown are the beginnings of the report periods represented by the data points.